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THE GEOGRAPHICAL REVIEW

CONTENTS FOR APRIL, 1937

PAGE

Kano: A Sudanese Metropolis 177
By Derwent Whittlesey

The Inversion of the Great Soil Zones in Western Washington . 200
By C. C. Nikiforoff

Migrations of Hungarian Peasants 214
By Erdmann Doane Beynon

The Nichols Mo-So Manuscript of the American Geographical Society 229
By Joseph F. Rock

The Centrographical Method and Regional Analysis . . 240
By E. E. Sviatlovsky and Walter Crosby Eells

Commercial Aviation in the American Mediterranean . . 255
By Carl Hanns Pollog

The Meteorology of Great Floods in the Eastern United States 269
By Charles F. Brooks and Alfred H. Thiessen

The Distribution of Pasture in Australia 291
By Griffith Taylor

Notes on the Findings of the "William Scoresby" in the Peru Coastal Current 295
By Robert Cushman Murphy

Madagascar: Great Isle, Red Isle: A Bibliographical Survey . 301
By Elizabeth T. Platt

Thirty-Third Annual Meeting of the Association of American Geographers 309

American Geographical Society 314

Geographical Record (*listed on the next page*) 323

Geographical Reviews (*listed on the next page*) 338

The Society is not responsible for the opinions or statements of writers in the Review

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GEOGRAPHICAL RECORD

NORTH AMERICA

Migration of Ethnic Groups within Cleveland. *By Erdmann Doane Beynon* 323

Erosion in the Piedmont. *By Lois Olson*.. 324

Maturital Soil Classification as an Aid in Analyzing Regional Settlement. *By Willis B. Merriam* 325

Administrative and Planning Regions in the United States. *By Stephen B. Jones*.... 326

SOUTH AMERICA

Iguazú National Park, Argentina..... 327

EUROPE

The Morphology of the Cities of the Alföld. *By Erdmann Doane Beynon*..... 328

The Center of Area and the Center of Population of Yugoslavia. *By Walter Crosby Eells*..... 329

POLAR REGIONS

Valley-Forming Processes in the Arctic. *By Richard Foster Flint*..... 329

A Bibliography of Novaya Zemlya..... 330

PHYSICAL GEOGRAPHY

Zones of Physical Comfort. *By Richard Joel Russell*..... 330

Steps toward a Physical Theory of Stream Action. *By John Leighly*..... 331

HUMAN GEOGRAPHY

Road Transportation..... 333

GEOGRAPHICAL AIDS

Recent Bibliographies on Latin America... 334

Recent Geographical Indexes..... 336

OBITUARY

Oliver Lanard Fassig..... 337

GEOGRAPHICAL REVIEWS

A. R. M. LOWER. **Settlement and the Forest Frontier in Eastern Canada.** HAROLD A. INNIS. **Settlement and the Mining Frontier.** *By C. P. Barnes*..... 338

Storm Rainfall of Eastern United States (Revised). *By Richmond T. Zoch*..... 339

MAURICE R. DAVIE. **World Immigration: With Special Reference to the United States.** *By Mark Jefferson*..... 340

CHESTER LLOYD JONES. **The Caribbean Since 1900.** *By Clarence F. Jones*..... 341

PAUL DITTEL. **Die Besiedlung Südnigeriens von den Anfängen bis zur britischen Kolonisation.** *By Robert H. Forbes*..... 342

R. SCHUILING. **Nederland: Handboek der aardrijkskunde.** *By A. de Leeuw*..... 343

KURT WIERSBITZKY. **Politische Geographie des australasiatischen Mittelmeeres.** *By Karl J. Pelzer*..... 344

GUSTAV FOCHLER-HAUKE. **Die Natur des Si kiang-Stromgebietes (Südchina).** *By George B. Cressey*..... 345

GUSTAV FOCHLER-HAUKE. **Das Waldkleid und die Pflanzenbezirke Süd-Chinas.** *By George B. Cressey*..... 345

NICHOLAS HUNTER HECK. **Earthquakes.** *By Ernest A. Hodgson*..... 346

CARL HANNS POLLOG. **Eisenbahn und Luftfahrzeug in ihrem Kampf gegen die alteren Verkehrsmittel.** *By Eugene Van Cleef*..... 347

GRIFFITH TAYLOR. **Environment and Nation: Geographical Factors in the Cultural and Political History of Europe.** *By Samuel Van Valkenburg*..... 348

Imago Mundi: Jahrbuch der alten Kartographie, No. 1. *By Dana B. Durand*.. 349

LEONHARD STEJNEGER. **Georg Wilhelm Steller: The Pioneer of Alaskan Natural History.** *By W. L. G. Joerg*..... 350

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PARTIAL LIST

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THE
GEOGRAPHICAL REVIEW

VOL. XXVII APRIL, 1937 NO. 2

KANO: A SUDANESE METROPOLIS*

Derwent Whittlesey
Harvard University

THE population map of tropical Africa piques curiosity at many points but nowhere more than in the vicinity of Kano. In the Sudan, a region commonly accepted as uniform in its environment, variations in population density suggest that this uniformity is illusory. In the belt between Lake Chad and the Niger River, the average density of less than 40 to a square mile is punctuated by districts of double and treble that density (Fig. 1); but none rival Kano and its surrounding district. On the 12,217 square miles of the administrative "Division" dwell more than 2,000,000 persons—164 to the square mile. More than half of these live in the *umland*, the immediately tributary area extending thirty or forty miles on all sides of the city. This area is well defined: within it hamlets lie hardly half a mile apart, there are about forty walled towns, and its well tilled farmland is almost everywhere bounded by unfarmed scrubby bush. The "home districts," within some ten miles of town, average 1300 persons to a square mile, with a total of 320,000. The urban area (city and township) has a permanent population of 89,000, swelled by an estimated 25,000 during the harvest season and by an additional daytime increment at that period of another 25,000. In all the Sudan only Khartum-Omdurman, at the confluence of the White and Blue Nile, has more people. In the western Sudan the District of Dakar, with about 50,000 people, is the only other urban area with a population of more than 20,000, and there are few of more than 10,000.

In population and business Kano has been eminent for a millennium and preëminent during more than a century. Since it has never been an important political capital, this growth in population, which is paralleled by increases in business, betokens an environment favored beyond the average in that part of the world.

*The author visited Kano in December, 1935, in the course of a field expedition to West Africa.

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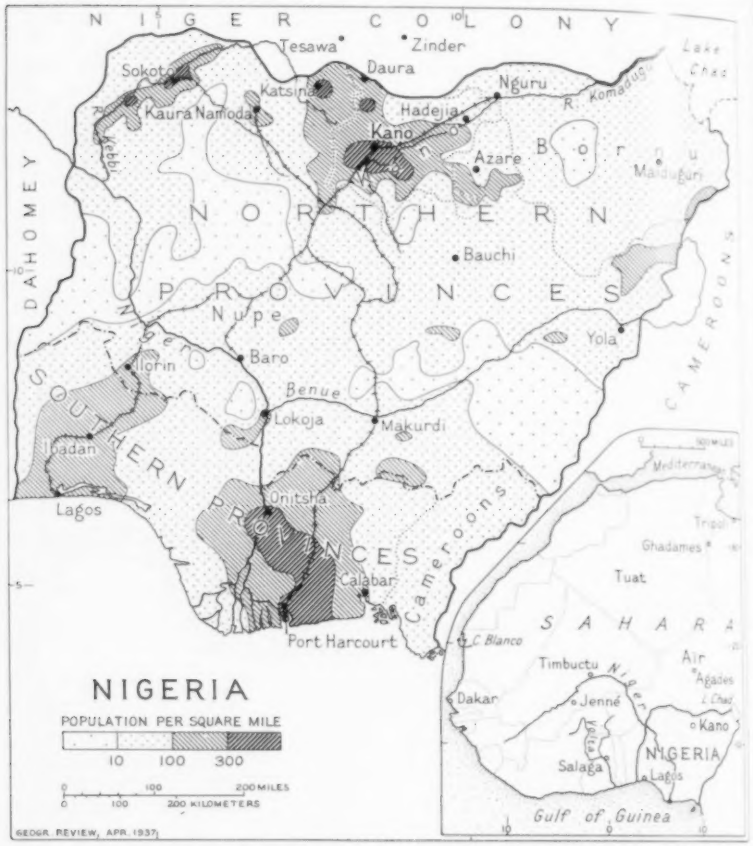


FIG. 1.—Map of population density in Nigeria, 1931. This map is reduced and simplified from the map by C. R. Niven in his paper "Some Nigerian Population Problems" (*Geogr. Journ.*, Vol. 85, 1935, pp. 54–58). See also Niven's paper "Kano in 1933" (*Geogr. Journ.*, Vol. 82, 1933, pp. 336–343). Scale of population map approximately 1 : 12,500,000; of the inset location map 1 : 80,000,000.

THE RURAL SETTING

The country around Kano is the most northeasterly area of highly productive farm land in the western Sudan. Scarcely more than a hundred miles north lies the Sahara; eighty miles to the eastward tillage gives way to grazing on the dry steppe of which Lake Chad is the center. Along this boundary small market centers—Zinder, Hadejia, Azare, and others—indicate outposts of arable land large enough to support autonomous groups. Yet even the most fertile soils of these districts have to lie fallow, and the fields are shifted every seven years or so. Around Kano, in contrast, all the arable land is in use season after season.

During the rainy half of the year field crops are raised: Guinea

corn (*Sorghum vulgare*), millet (*Pennisetum spicatum*), and peanuts chiefly; cotton, sweet potatoes, manioc, sesame, henna, and calabashes as minor elements in the crop association. For these drought-resistant plants the 36 inches of rain are adequate, being concentrated (but for 2 inches) in six consecutive months. Throughout the year gardens are maintained along the sluggish streams that creep across the undulating plain, irrigated with the shadoof or by water carried in calabashes. Onions, tomatoes, sugar cane, tobacco, and peppers are leading garden crops. Neither garden nor field would thrive so well but for the high ground-water table, reached by wells ranging in depth from 15 to 40 feet. The Kano *umland* comprises the uppermost basin of the Komadugu, affluent to Lake Chad. Its borders are marked by a lower water table. Downstream the dip of bedrock surfaces can be traced in the increasing depth of wells—to 150 feet near the confines. On the other sides belts of higher ground are covered with "small bush" of thickly set low trees of many species, most of which lose their leaves during the dry season, and an undergrowth of coarse savana grasses. This contrasts sharply with the Kano landscape—parklike vegetation of fine big trees, locust bean and others, which retain their dark green crowns all year round (Fig. 2), and tilled fields or heavily grazed herbage. The belts of dense bush are used for grazing during the wet season; otherwise they are wilderness except for widely spaced, poor towns along routes.

The soil, derived from the underlying granitic rock, is not notably rich; but it is easy to work, being light and friable, in contrast with the dense clays on lateritic hardpan that occupy much of the Sudan. This virtue is of the first order among primitive people restricted to simple tools for cultivation. The soil responds well to fertilizer, of which it requires a good deal. The nomadic Fulani, who own all the cattle of the region, are paid to pasture their herds on stubble fields during the dry season. Farmers and cityfolk own goats, sheep, and beasts of burden. Pack asses are especially numerous in the city. The "home districts" are the most intensively worked, partly because of the larger available supplies of manure in Kano. During the past three decades peanuts have come to be a large item in the crop association, adding their wealth of nitrogen to the soil. The reliable supply of food for the urban population from the surrounding farms has been a basic factor in the evolution of Kano as a metropolis.

Origins and Early Days: Handcrafts

The origin of Kano is veiled in mists of legend. Tradition holds that the site was fixed by the presence of workable iron ore[1] on the

[1] Native iron working is of considerable antiquity in West Africa and is practiced to this day in many places. See R. H. Forbes: The Black Man's Industries, *Geogr. Rev.*, Vol. 23, 1933, pp. 230–247; reference on pp. 230–236.

lateritic cap of Dalla hill, a granite-cored inselberg rising a little more than a hundred feet above the gently undulating plain (Fig. 8). The earliest recorded date for the city is 999 A.D., and a chronology of its rulers begins with 1060.[2] There seems to have been a settlement before this time, because West African states are known to have existed from the third century, and legend tells of the killing of a snake (perhaps a totem) that the primitive inhabitants worshipped on the banks of the Jakara. The reputed founders of the town came from the north or east, as did the founders of all the other important cities of the Sudan. Groups of immigrant people continued to settle in the district from time to time. During the latter half of the fourteenth century Mohammedanism was introduced to Kano —long after it had been accepted in the region of the Middle Niger and in the Lake Chad country. By the fifteenth century caravans were moving between Kano and the Mediterranean Sea. Less than a hundred years later salt from Aïr in the Sahara had become a commonplace. For a time a king of neighboring Bornu, who introduced firearms in

[2] For this and the outlines of the legendary founding see C. K. Meek: The Northern Tribes of Nigeria, London, 1925, Vol. 1, pp. 69–78.

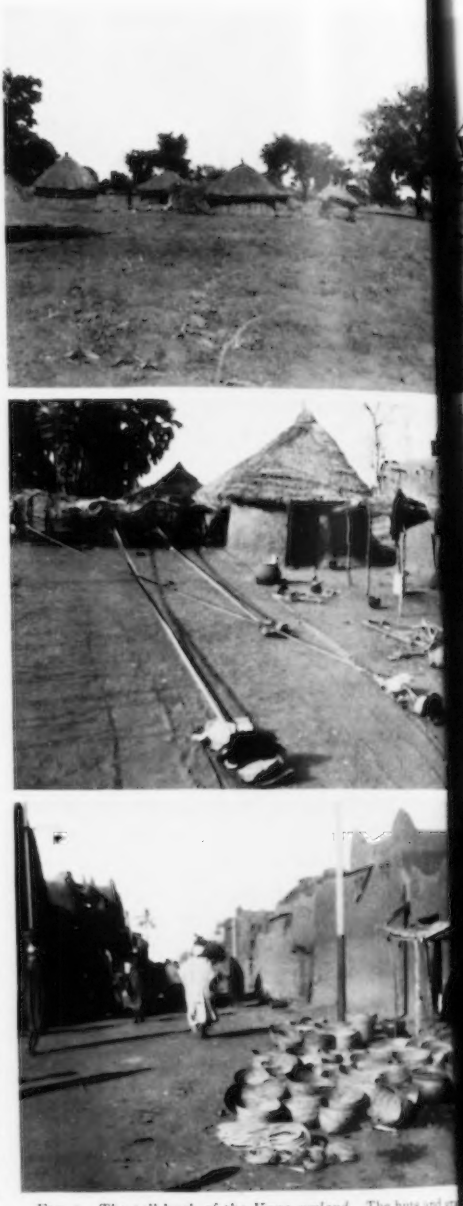


FIG. 2—The tall bush of the Kano *umland*. The huts and gra[illegible] belong to a village about five miles from the city.

FIG. 3—Typical Sudanese looms. The weavers sit und[illegible] shelters.

FIG. 4—Baskets on sale in a better-class street of Kano. [illegible] peddlars bear jars on their heads.

6—Dye pots. The basketry frames are used for drying dyed

6—The tanning compound. Leather is generally dyed as tanned.

7—Groundnuts piled in a store compound awaiting shipment. Township.

the sixteenth century, supposedly from Tripoli, dominated the district and most of the city except the natural defensive point of Dalla hill.[3]

Smelting appears to have died out at Kano with the increase in population that depleted the local supply of wood for charcoal. Blacksmiths continued to ply their trade, in recent centuries being removed to the vicinity of the market, on the side of town toward Dalla hill. Until the Sudan was caught up in the meshes of world trade at the end of the nineteenth century,[4] they turned out spears, daggers, hoes, and the local broad triangular stirrups; they set sword blades and the imported razor blades; and they worked in silver and brass. But though iron working may have been the craft first practiced in Kano, for some centuries it has been overshadowed by others.

The city's most famous product has long been a coarse, soft cloth, woven in strips from four to ten inches wide and sewn together into widths sufficient for articles of clothing. Until recent decades the cotton came from native-grown tree species. Spinning is done with a spool distaff, and the loom is a light and simple affair manipulated with fingers and

[3] Meek, *op. cit.*, Vol. 1, p. 81.

[4] Meek, *op. cit.*, Vol. 1, pp. 149–150.

toes (Fig. 3). Unlike the ubiquitous spinning and weaving, dyeing is concentrated at a few points, mostly in or near the Dalla quarter and generally where ground water is readily available. Barth reported more than 2000 dye pots in the city in the mid-nineteenth century. In spite of its magnitude, the business remains a hereditary household industry, being the traditional craft of certain families (Fig. 5). Locally grown indigo furnishes the predominant blue dye. Colored stripes or more elaborate patterns are sometimes woven into the cloth: red has long been obtained from the stalk or leaf of grain sorghum, yellow from the root of an acacia, and black from boiling iron in an infusion of Guinea corn; but coal-tar anilines have been utilized of late, particularly purple and green, of which the Moslem craftsmen are inordinately fond. Further embellishment of the cloth is accomplished by embroidery. The sewing of cloth into garments, especially the flowing *riga* worn by the men, is concentrated today in the central market, where sewing machines hum busily. This "tailoring," alone of all the Kano industries, has escaped the household. All the work on cloth, from spinning to embroidering and sewing garments, is done by men.

After cotton cloth, leather is the leading household craft of Kano. Goatskins are tanned and dyed to make what the world knows as morocco leather. There is an unsupported tradition that the art was developed on the south side of the Sahara. Sheepskins and cowhides are tanned and, with goatskins, make up the trade product. Camel and ass hides are tanned for local use. The tanning material is the nut of an acacia. The business is carried on along certain streets and in compounds (Fig. 6), mostly in the vicinity of the slaughterhouses (the quarter of the Wambai gate).

The slaughtering of meat, chiefly beef, is an important daily business, being concentrated along the sluggish stream that drains the city, just above its exit through the wall. Meat is dried all through the town, to make a sort of chipped beef. Thin strips are exposed to the sun on racks of Guinea-corn stalks; the meat dries very quickly, but not without accumulating street dust. The meat-drying frames, head-load rests, mats, calabash utensils, and many other simple household articles made from farm products are fashioned in the villages and brought to Kano on the head of the maker or a middleman.

Early Trade Developments

In the productive farm land and in the skilled handcrafts based on local raw materials were the seeds of a commercial metropolis. When the earliest European adventurers penetrated the Sudan they heard reverberations of the wealth and glory of Kano. As in the cases of Katsina, Jenné, and Timbuctu, the fame appears to have exceeded

the fact. Nevertheless, the existence in primitive Africa of walled cities whose merchants traded from the Mediterranean littoral to the coast of Guinea and from the Atlantic to Darfur is surprising, and inevitably their reputations spread beyond their goods.

For participating in this trade Kano is well situated. The central route across the Sahara connects the Tripolitan coast with Aïr and strikes the Sudan immediately south of that moist highland, either at Tesawa and Katsina or at Zinder and Daura, whence the two forks converge on Kano. In the Sudan the clumps of inselberge can easily be avoided, and the low ranges are cut apart by gaps. The thickets of small bush form more extensive barriers. Where they cannot be avoided they are traversed at narrows. Southward from Kano routes pass west of the rugged Nigerian plateau to traverse the lightly peopled small bush between the Kano and Zaria lowlands at its narrowest place.[5] Transverse to this north-south route is a highway along the Sudan, in the latitude of Kano and at a safe distance from the desert. From the east this route is a principal exit from the landlocked central Sudan; and Kano, the first well watered district, has long been a market for cattle and hides of the steppe country.

FIG. 8—Map of the city, showing the Dalla defense point and original settlement (1) and successive concentric walls (2).

All the towns in this part of the Sudan were actively engaged in trade for centuries before Europeans appeared on the scene. Leo Africanus, who visited Kano in the early sixteenth century, says of it,[6] "The inhabitants are rich merchants and most ciuill people."

[4] Katsina possesses an advantage over Kano in that a road leads westward directly to Sokoto, and, according to Barth, during the seventeenth and eighteenth centuries Katsina outranked Kano as a commercial city. If, as some believe, the average rainfall was greater then than now, Katsina, along with the still more northerly towns Jenné and Timbuctu, would have had a further advantage at that time.

[5] Leo Africanus: The History and Description of Africa. *The Hakluyt Society, 1st Ser., Nos. 92–94*, London, 1896: reference in Vol. 3, p. 830.

Mixed in origin, the sedentary people had come to speak a common language, Hausa, and the section of the Sudan from the Middle Niger to the Lake Chad steppe was and still is known as Hausaland. The Hausas are the farmers of the region, and they have also mastered the art of chaffering. Today Hausa colonies are to be found throughout West Africa, on the coast as well as in their native Sudan.

Wandering over the steppe and bush of the northern Sudan and pushing into tilled districts as the dry season advances is a very different group, the Fulani, nomadic herdsmen. The Fulani possess physical characteristics that ally them with the Hamitic peoples rather than with Negroes. Fanatical Moslems all, a few of their number have been settling down in permanent quarters in the Hausa towns since the end of the thirteenth century. In Kano they and other more recent immigrants commonly built their compounds south of the Jakara, and by the end of the eighteenth century they were numerous enough to have doubled the walled area of the town (Fig. 8).

Kano's position of unquestioned supremacy in West African trade may date from the Fulani revolution at the beginning of the nineteenth century. Undertaken by sedentary Fulani to reform the corrupt Mohammedan center of Gobir in the Sokoto country, the movement soon spread as a Holy War to all the Hausa states and beyond. Katsina, probably the commercial metropolis of Hausaland, resisted for some time, whereas Kano fell promptly. Apparently this led many merchants to move to Kano where business could go on uninterrupted by warfare. By the time the first European visited Hausaland (1824) Kano had eclipsed its rival.

Nineteenth-Century Kano

From the accounts of the few European travelers who ventured thither the Kano of the nineteenth century can be reconstructed.[7] One approaches the place on camel, horse, ass, ox, or afoot, through the fields, green with tall grain or yellow-brown in stubble and dotted with large green trees. The two isolated mesas, Dalla and Gorun Dutsi, are the first welcome landmarks to be seen. Then a line of crenelated mud wall emerges from the russet landscape, rising from 30 to 50 feet above a wide belt of open land, unencumbered by buildings or crops. Here and there a giant kapok tree marks a gate (Fig. 11). On closer view the walls are seen to be pierced with loopholes and encircled by a deep ditch filled with live thorns and divided by a mud wall running along its center. Each gate, of cowhide stretched over a wooden frame, is set in a massive entrance tower through which a tortuous path, two or three score feet long and wide enough for only

[7] For the appearance and the "feel" of the town see especially the descriptions of Barth and see also F. D. Lugard, Annual Colonial Reports, Northern Nigeria, 1900-1911 and his "Northern Nigeria," *Geogr. Journ.*, Vol. 23, 1904, pp. 1–29.

FIG. 9—Map of Kano in the nineteenth century. Reference: 1. the built-up city; 2. cemeteries; 3. pools and borrow pits; 4. principal thoroughfares. The large rectangle represents the Emir's compound.

a single horseman, must be followed. The walls outline a crude trefoil having a perimeter of more than eleven miles and representing successive enlargements of the city (Fig. 8).

Inside the gates of the city itself are quarters for its keepers and defenders and their families. Beyond a belt of open ground rise irregular and congested blocks of dwellings, occupying not more than a third of the eight square miles enclosed by the walls.[8] These open lands are fields and gardens, intended to supply food for besieged citizens. At the north the wall is thrown out to incorporate a segment of a rivulet that provides water for irrigated gardens. Half a dozen

[8] For sketch maps of early Kano compare the following: Dixon Denham and Hugh Clapperton: Narrative of Travels and Discoveries in Northern and Central Africa, in the Years 1822, 1823, and 1824. London (and Boston), 1826; Henry Barth: Travels and Discoveries in North and Central Africa, 1849–1855, 5 vols., London and New York, 1857–1858, Vol. 2, p. 107; Lugard, Annual Colonial Reports, p. 165.

hedges enclosing untilled acres mark cemeteries with successive generations buried in the same soil. Nothing is left of the abandoned city walls, the mud of which they were made having been promptly seized upon as material for the adobe houses of the town. They can be traced by their moats, however; dry in parts, elsewhere filled with water during the rainy season and still moist at the end of the dry months. Only where causeways lead to the tortuous streets of the built-up town are the moats obliterated.

The construction of the town, though solid, is ephemeral. Two sorts of houses are interspersed. A modified Levantine type dominates the older quarters and is common enough everywhere. It is an affair of mud, built up of hand-packed balls bound with straw and smeared with more mud to protect the core and to give a finished surface. The walls of the compound are continuations of the house walls and rise six to twelve feet above the streets. The better houses may have a small second story; here and there a façade is embellished with designs crudely etched in the wet mud. The flat adobe roofs, supported by mud vaults and reinforced by fronds of the handy and termite-resistant fan palm, sooner or later begin to leak. They are still made, because they serve as terraces where householders may sit to get the refreshing evening air and sleep in the dry season. Scattered about, most numerous in the southerly Fulani quarters, are mud huts with conical roofs of thatch, each family being housed in its separate walled compound.

Whatever the design, the material soon degenerates, and patching and rebuilding require straw from the surrounding farms, for thatching, and especially mud, dug from the nearest open space, for walls. As a result, the whole city is pockmarked with borrow pits, distinguishable from old moats by their haphazard distribution and their odd shapes. The largest exceed 500 feet in diameter; most are 100 or 200 feet in diameter and 20 or more feet deep. During heavy rains they may overflow, but the rest of the year their stagnant water is a breeding ground for mosquitoes. They are, however, handy for washing, and ducks live on the weeds that cover the bottom. Besides they help maintain a high water table. Wells, sunk to depths of ten or twelve feet, are the sole source of drinking water in the dry season, except for jarfuls brought in from springs outside the city and peddled through the streets.

In the heart of the most congested district the Jakara forms a deep double pool, bridged at a constriction in the center. Upstream the marshy flood plain effectually prevents housebuilding. Downstream, at the cattle market and slaughtering place, the river is used for disposing of refuse. The borrow pits and the Jakara "sewer" are among the agents that make the city unhealthful. The haze of dust stirred up during the dry season is an active carrier of diseases.

The north bank of the Jakara, once the edge of town, has become the central market, the biggest in West Africa. The old market consists of mud sheds with cavernous openings, ranged along parallel lanes. Each type of goods is sold in a particular section—small wares within the sheds, bulky commodities outside. Camels and pack oxen are sold on the northeast side of the sheds, between the sheds

FIG. 10—View of the main part of Kano, from Dalla hill showing borrow pits and the adobe town, From Dalla hill.

and the slaughtering place; firewood, along the west side; slaves, in the sheds in the northwest corner. At the height of the season chaffering overflows into the streets and especially along the Jakara, at this season a shrunken, sluggish pool.

"The market of Kanó is better supplied with articles of food than any other market in Negroland."[9] Surplus grain from the surrounding farms makes up the bulk of it. Salt comes in from the desert. There are sugar loaves from France; spices, especially cloves, from various remote regions; frankincense and rose oil from the Mediterranean. From the Guinea forest more than 500 ass loads of kola nuts enter annually. These serve both as a medium of exchange and as a highly prized stimulant. Some are transshipped to points in the farther Sudan and in the Sahara. Natron from salt pans in the Lake Chad country, estimated at 20,000 pack loads a year, changes hands in the market. Some is sold locally for soap, but most of it is destined for the margin of the rain forest, where it is used in preparing the staple food, yams. Antimony for cosmetics and small quantities of

[9] Barth, *op. cit.*, Vol. 2, p. 143.

copper, zinc, tin, and silver enter the city. Foreign manufactured goods include articles of Arab dress from Tripoli, particularly dyed silk; cotton prints from Manchester; silks from France and Italy; paper, small mirrors, needles, razors, and sword blades from German states; beads from Venice.

Besides the central market there are eight lesser ones. Four are

FIG. 11.—A city gate with its kapok tree and the daily market that springs up in its shade.

just outside the principal city gates and are daytime pitches (Fig. 11). Four are on plazas near the margins of the built-up area.

Business is in the hands of four groups of traders. Hausas are by far the most numerous. They chaffer in the markets and are in charge of the caravans of asses, sometimes attended by other livestock, that carry cloth, leather, natron, and Mediterranean goods to the densely peopled Yoruba country and the coast. Returning, they stock with hardware and Manchester goods and particularly with kola nuts.

The other three groups are foreigners with special interests. Resident merchants from Aïr, settled originally southwest of the market, supervise the trade of their kinsmen, who come in during the dry season riding camels or oxen and bringing salt and slabs or lumps of natron and driving male livestock—cattle, hairy sheep, and goats. They take back the dark-blue cloth in which they swathe themselves, hardware, and kola nuts. A small group of Arabs from Tripoli and Berbers from Ghadames operate camel caravans between Kano and their homeland—trains of a thousand beasts or more. From the north come dyed silk, making up a third of the whole Ghadamese trade, burnooses, magenta-colored wool, thread, sweets, scents, spices, and tea. In return go leather, feathers, and a little ivory. These

men live in the old Dalla Quarter and look strikingly white among the Hausas and even the Fulani. A community of traders from Salaga in the Volta country (Fig. 1) imports kola nuts from the important producing areas in the margin of the forests both east and west of the Volta River. They send back cloth, leather goods, antimony, potash, and livestock.

FIG. 12.—Festivity after the Sala, the prayer service concluding Ramadan.

The town is divided into 137 wards, grouped into 14 quarters, each ruled by a headman. Besides, most of the rural headmen live in the city much of the time, and each keeps a house there. They, with the Emir and his administration of 46 principal officers,[10] comprise the aristocracy, and their spacious compounds occupy a good deal of ground in the southern part of the town. The Emir's rectangular compound of 33 acres surrounded by a wall about 25 feet high is the heart of this commodious quarter (Fig. 9). Near by are the official residences of his chief subordinates, including large houses of favorite slaves, and the police barracks. Across a narrow street stands the principal mosque of the city. Like most mosques in this part of the world, it is scarcely larger than a first-class dwelling, but alongside it rises the most conspicuous structure in town, a truncated pyramid (Fig. 16) built in emulation of the minaret in rival Katsina. Other mosques inconspicuously serve other parts of the town.

Although Fulani dominate the southerly quarters, and Hausa the northerly, there is a large Hausa district to the west of the Fulani section. On the northwest edge of the built-up area dwell most of the southerners, Nupe and Yoruba folk. To the east of the old Dalla core live immigrants from the country toward Lake Chad and the

[10] Lugard, Annual Colonial Reports, p. 109.

Upper Benue River. The distinctions between the quarters are less apparent in the house forms and street patterns than in the dress and physical type of the people.

So much for a picture of Kano as it was in the nineteenth century. What changes has the twentieth century wrought in its aspect?

FIG. 13—The decaying walls of Kano, showing construction.

TWENTIETH-CENTURY CHANGES

In 1903 a British force marched into Kano. Although the new masters retained the Emirate, a third of a century of British suzerainty has changed the city more than all the centuries under Hausa and Fulani rule. The first official acts of the British government on seizing the city stopped slave trading and imprisonment of malefactors in dungeons and inaugurated a reform of administration, including taxation. The former slave market is now filled with inanimate merchandise, and a new and clean prison stands just outside the Emir's enclosure. The village headmen live in the towns administered by them. Money is raised by a poll tax, uniform assessments on real estate and on cattle, and fixed monthly rentals for stalls in the market.

The population, probably more than double what it was in 1900, has somewhat filled out the figure of the earlier city (Fig. 15). On the east it is now solidly built up to three of the easterly gates, and isthmuses of habitations follow the roads to the three gates of the southeast lobe. Government undertakings occupy part of the ground remaining on this side. These include a wholesale market under sheds, an elementary school with a large playground, a girls' school, a lunatic asylum, a hospital, a school of hygiene, a workshop and garage for the city engineer, and a veterinary center for treating cattle.

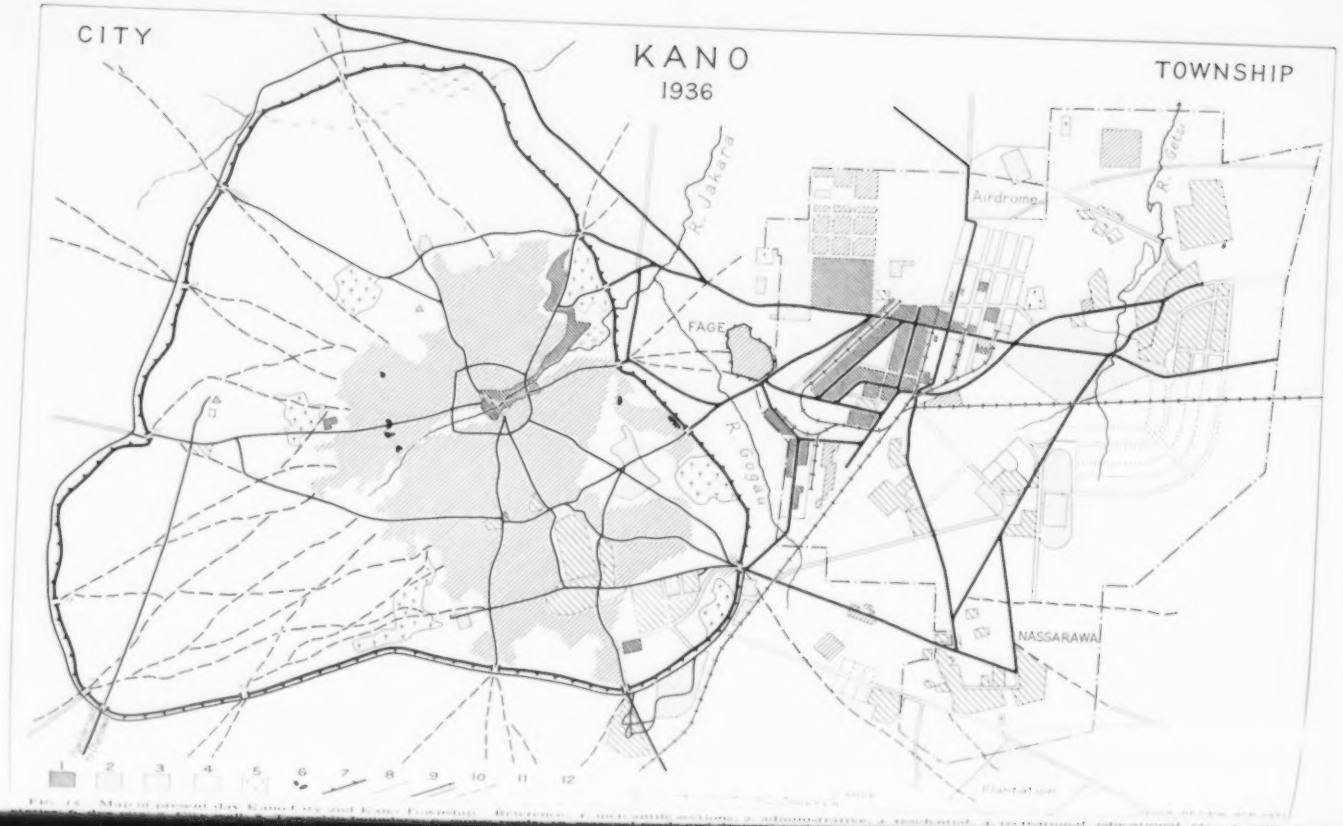
The very listing of these institutions, unheard-of under earlier dispensations, is an index of profound social alteration. Outside the walls are the printing and survey department and the Middle School, covering, with its farm, nearly 50 acres. Most of these new public buildings are constructed in the traditional style, but of concrete and

FIG. 14—A recently repaired gate. The broad straight opening and the concrete bridge across the moat are twentieth-century alterations.

with roofs of corrugated iron concealed from the street by a parapet. Concrete-and-iron construction costs only about two-and-a-half times as much as adobe; upkeep amounts to scarcely one per cent a year, compared with 15 per cent for an adobe building.

Cheap slave labor is no longer available to maintain the now obsolescent walls, which are gradually washing into the moats (Fig. 13). In many sections they have been eroded to broad embankments not more than 25 feet high and crossed by footpaths. The gateways, now widened for motor traffic, are kept up, and the formality of closing them nightly is continued.

Much has been done to improve sanitation. The offal of slaughtering is properly disposed of, and a new concrete meat market adjacent to the central market can be washed down daily. The Jakara alongside the market has been confined to a narrow channel, and the bordering marsh is being filled in. The adobe of abandoned houses is thrown into handy borrow pits, in an effort to reduce the mosquito menace. New houses may take material from designated places only—land that is high enough to drain itself. The government urges the replacement of latrines by dry closets, the soil to be buried in trenches, subject to removal for fertilizer after two years, when danger of disease is deemed to be past.


CITY
KANO
1936
TOWNSHIP
R. Jakara
R. Getsi
Airdrome
FAGE
R. Gogau
NASSARAWA
Plantation
1 2 3 4 5 6 7 8 9 10 11 12

A public water supply was opened in 1931, and the wells within the city sealed. The largest available source of water is the bed of the Challowa River, which flows in a sand-filled valley excavated in granite. In the dry season the Challowa disappears, but the natives have always obtained water by digging holes two or three feet into the sand. At the point in the stream's course nearest Kano, about a mile from the railroad bridge, five wells have been dug to depressions in the granite floor of the channel, some forty feet below the surface of the sand fill. The curb of each well is elongated to a tower 30 feet high. There, perched out of reach of the highest flood-water, an attendant looks after an electric motor that drives the pump. A nine-mile pipe line (Fig. 15) carries water under pressure to a reservoir atop Goron Dutsi, the highest point near the city, from which it is distributed by gravity. The demand upon the waterworks is lowest (250,000 gallons a day) in the wet season, when people drink, bathe, and wash least, and when they catch rain water to save trips to the hydrants. Towards the end of the dry season, when the daytime temperatures rise to 100° F. and the city chokes in dust, partly from the desert wind (harmattan) and partly of its own making, more than twice the minimum is used (550,000 gallons a day). Payment is made by a small levy against every dweller.

Kano, like every metropolis, has its traffic problem. Riding horses, laden asses, bicycles, camels, automobiles, sumpter oxen, pedestrians —many conveying head loads of hides, water, meat-drying racks, and peanut vines—get mixed up with the sheep, goats, chickens, and shouting children. The congestion increases towards the central market, which now covers more than 15 acres and contains hundreds of regular stalls, not to mention pitches in all the adjacent streets.

A few roads, wide enough for two automobiles to pass, have been made by cutting off projecting compounds and houses, and in places short-circuiting zigzags (Fig. 15). Seven of these new roads converge at the market, around which they pass by a belt road with parking spaces. These new streets connect at the city gates with the main roads to other centers. Outside each main gate a park for motor-buses and a small market relieve the pressure on the central market. Several principal highways have been adapted to automobile traffic in all weather by bridging unfordable streams and surfacing the widened highway with laterite. However they are few in comparison to the crisscross of pack routes, some of which are passable for motors during the dry season. Sand is their chief drawback, and the sharp banks of arroyos are additional hazards. The laterite road from Kano to Zaria is 170 miles long, whereas the dry-season road is only about 90 miles long. With gasoline always at a stiff price, the saving of distance is a temptation, often regretted.

The Township and Its Functioning

The intricate road pattern has been given new significance by the railway from the coast. The cheaper and speedier access to the outside world has practically eliminated the trans-Saharan caravan and has caused a reorganization of production in the Kano trade

Fig. 16—The pyramid near the mosque. The festival closing the fasting month, Ramadan, is being celebrated.

territory and added many new items to the list of commodities on sale in the Kano markets.

To accommodate the new commercial activity, as well as the political administration retained in British hands, a new feature has been added to the landscape. This is the "Township," which occupies almost as much land as the city (Fig. 15) but contains only 7000 of the 89,000 inhabitants of urban Kano.[11]

For several reasons—policy, health, comfort, economic convenience—British settlements in West Africa stand aloof from indigenous towns.[12] The first quarters occupied by the British authorities at Kano were at Nassarawa, where the residency and most of the government offices still are housed in quarters built during the past three decades (Fig. 15). The selection of this site and the planning of the Township proper are recounted by Lugard.[13] The question of a local

[11] Technically the Township is an area of slightly more than five square miles conceded to the British authorities by the Native Administration of Kano Emirate. In common parlance the term implicitly includes also the "Government Layout" at Nassarawa, nearly two square miles more, adjacent to the Township on the south.

[12] The fundamental concept of government is to advise and guide the native ruler, not to supplant him. See Derwent Whittlesey: British and French Colonial Technique in West Africa. *Foreign Affairs*, Vol. 15, 1937, pp. 362–373.

[13] Lugard, Annual Colonial Reports, pp. 242–243.

supply of pure water has been solved by laying on Challowa water from the city waterworks. The scattered sections of the town make a system of sewerage prohibitive, but the method of dry closets and disposal in trenches is universal. Roads in all the settled districts totaling, with the city streets, 50 miles, are lighted. Electricity is

FIG. 17—Camels bringing groundnuts into the Kano market.

used by Europeans for lights, fans, and refrigerators. Streets are well surfaced, most of them with laterite, a few with tarvia. The 360 Europeans and Asiatics (Syrians) do not support a newspaper, but short-wave radios keep them in touch with the world, or at least with the Empire.

The Township has no defensive wall, but all along the easterly side a zone 1200 feet wide is designated to be kept free from buildings to avoid nearness to indigenous populations. Towards the city the same end is served by the traditional military belt about the Hausa walls. At one point, however, the combined stores, shops, and habitations of the Syrian Quarter approach to a point 800 feet from the city wall and even closer to Fage.[14]

For several years the railhead was in Kano, and the street pattern of the commercial quarters is oriented to a convenient layout of spurs from the terminal station. Later the line was continued 150 miles to Nguru, at the border of the steppe to the northeast, and for convenience was projected through a zone then and now unoccupied. Beyond Kano there are at present but three trains a week in each direction. Kano, with trains every day, remains the effective terminal.

[14] Fage, the only occupied native area abutting the Township, is under the jurisdiction of the Emir. It is supposed to be occupied by Hausas migrated in recent times from other states. It has an evil reputation as the haunt of scalawags from the city.

In a savana nearly a thousand feet wide and a mile long near the station and between the Syrian Quarter and the European commercial area is space for animal parks. Small trains of camels or oxen may pause there. Cattle pens facilitate loading directly into cars. One cattle train of eight or ten cars is sent weekly to Lagos. The animals are steers and bulls of the wide-horned, humpy Fulani breed, most of them from the steppe, driven in by Hausas who have bought them from their nomadic owners. Once a week also, at least during the season, several hundred asses are assembled to pick up a shipment of kolas, which come chiefly from the vicinity of Lagos. The kola nuts are produced and consumed entirely by Africans. They are perishable and lose their stimulating property after a few weeks. The trade is wholly in the hands of the Syrians and of the Tripolitans who live in the district between the principal mercantile city gate (Wambai) and the central market. The big crop comes to market during the early dry season, although a few nuts are produced the year round. When the height of production coincides with one of the Mohammedan festivals, the shipments are enormous. It required three days to discharge the trainload sent in the week of Ramadan Sala in December, 1935.

The principal quarter of stores stands to the north of the savana. Several of the large firms occupy whole blocks, and all these have direct access to rails as well as to roads. Their business is wholesale and retail, and most firms handle everything. Most space is occupied by cheap cotton cloth of many sorts. Utensils for the household vie but generally take second place. The trader's job is divided between sale of European goods and purchase of local surplus.

One ancient product of Kano, skins, surpasses the production of former times. Kano has become the collecting center for all the export hides and skins of the Sudan from Katsina to beyond Lake Chad and well into the Sahara. This section yields about twice as many skins as the rest of the western Sudan. Nguru, at the end of rails, is a subsidiary center, gathering from a radius of forty or fifty miles and shipping direct to the coast or to Kano. Skins generally come direct to Kano from distant points off the rails, carried in caravans of camels, oxen, or asses. Motor trucks bring in increasing proportions, and near-by individuals tote their small surpluses on their own donkeys. The big companies post purchasing stations at convenient points in districts of concentrated production. Other companies advance funds to African middlemen who buy for them where they can. The area tributary to Kano is bounded by the two collecting centers Sokoto and Maiduguri shipping to rails at Gusau and Jos respectively.

Goatskins lead in number—five times as many as cowhides and eight times as many as sheepskins. Quality varies with origin and

season's goatskins from the Sahara margins and the cowhides from the drier steppe are inferior to those procured in the moister country near Kano,[15] and quality is best from December to May. Government agents are undertaking to teach better methods and to inculcate careful preparation by inspecting and stamping every pelt properly cured.

When the skins reach the sheds of buyers in Kano, they are immersed in a tank of dilute arsenic compound. This kills worms, cleans the pelt, and softens it for redrying in a more compact form. Most companies send their bales (200 or 300 of the small skins, fewer of cowhides) to Lagos, the principal seaport. The largest of the firms, having its own vessels, sometimes ships to the alternative and equally distant Port Harcourt or to the head of navigation on the Niger at Baro (just half the rail mileage) and thence by river boat to the margin of the delta. A certain number of skins are prepared locally, as already described.

During the forty years since peanuts were introduced to West Africa the Sudan has become the world's chief producer. The whole area tributary to Kano, which includes French Niger province, ships about 150,000 tons, nearly a fifth of the total Sudanese output. In volume this crop is the biggest in the region, and probably it leads in value also. It is mainly peanuts that create an annual famine in freight cars during the harvest season, the two railheads, Nguru and Kaura Namoda, sharing the physical handling with Kano, although Kano finances almost the entire Nigerian crop. The product is shipped in gunny sacks, and piles 15 feet high accumulate in the company compounds, requiring no protection in the rainless weather of the harvest season, December to April.

Buying is managed very much as in the case of skins, with one important difference. Syrians, who refrain from trading in skins because of its technical character, are active in the peanut trade, in competition with the European firms. Even Tripolitan Arabs engage in it, the local community being augmented from the north during the dry season. Every day trains of a dozen to 150 animals—camels, asses, more rarely oxen—bring in loads from outlying territory. The asses make short trips, the camels go to the desert margin. Most of them are in the hands of Tuareg from Aïr, easily distinguished by their dark blue burnooses and the blue veils worn by the men over their mouths. They come down with salt and natron as the dry season begins, usually in October, and make as many trips for peanuts as possible before April, when the end of harvest and the rains release them to their homeland. The peanut-carrying business has been the chief instrument of saving a vestige of the trans-Saharan caravan trade. One or two trains of a thousand or more camels come in from

[15] Local farmers dry peanut vines and other green forage for feed, thus obtaining better hides.

the Tripolitan desert each dry season with Mediterranean and Saharan merchandise and then split up to carry peanuts for a few weeks, precisely as is done by the men of Aïr.

Cotton production in the Kano umland is unimportant, being confined to unirrigated gardens to supply the grower with his needs. Since American types have supplanted native tree cotton, the Zaria and Katsina districts have proved better suited to growing the crop, Kano being too sandy. There is a ginnery on the railroad at Challowa, twelve miles from the township station. It was installed in what proved the false anticipation of an increased crop in the region and it now handles the Katsina crop. Hand spinning, weaving, and dyeing continue to be important business in Kano.

Missionaries, traders, and political officers, to the number of 360, make up the European population of Kano. Within the European commercial quarter of the Township are two small resthouses that serve as hotels for transients. These are unique in interior British West Africa and are there because the railroad maintains one of them for its passengers and the French government subsidizes the other for people making the trans-Saharan automobile trip. The post office and the office of the waterworks are also in this section.

Much of the land of the Township is occupied by or reserved for the British administration. The government offices are housed in rather bleak two-story concrete buildings with shady verandas. Dwelling houses for the European officials are somewhat in the native style, and the older ones are made of adobe. These structures and the Residency, at once home and office of the real ruler of the whole Kano Province, stand amid the big trees that attracted Major Lugard when he captured the town. The Emir's rural retreat for which the trees had been cultivated is again occupied by the African ruler whenever he wishes to escape the city. The northeast corner of the Township is given over to the resident companies of the Royal West African Frontier Force, African troops commanded by British officers.

Political and commercial activity has attracted many immigrants from other parts of British Africa, to serve as houseboys and as clerks. The houseboys come from the coast where they learned to serve white men. The clerks came at first from Sierra Leone, then from the Gold Coast, and later from the coast of Nigeria, where schools teaching English and clerical techniques have been progressively established. To accommodate these "foreigners" an African town has grown up in the northwest corner of the Township. Its streets are wide, its plan is a gridiron, and its architecture is a hotch-potch of African and European styles and materials. Its local market is big and active, considering that the total population of the place is only 6600. Small churches of several denominations are the only public buildings. Be-

tween this town of "southerners" and Fage there is a small mission, including a school and a hospital. In Moslem British Africa missionary activities are forbidden except by express permission of the Emir.

To the south, spilling over beyond the borders of the conceded territory on the fertile plain not far from the Emir's private irrigated garden, is an experimental farm. To the north is the flying field[16] in use by the newly installed airmail service between Nigeria and the Gold Coast and Khartum where connection is made with the Cape to Cairo route. With these two occidental features as an earnest of the future we may take leave of present day Kano.

[16] The field in use at present is an extension of an emergency landing field: it is too near the native quarter (danger of yellow-fever carrier) to meet the regulations of the International Health Convention and a new airdrome is planned.

THE INVERSION OF THE GREAT SOIL ZONES IN WESTERN WASHINGTON

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A LARGE portion of eastern Washington is occupied by the dark-colored soils of the Palouse and closely related series. These soils belong to the chernozem group. The development of the chernozems is a mass effect of a certain natural combination of definite climatic conditions, grass vegetation, and topographical configuration of the general landscape. The great geographical unit known as the northern horizontal zone of chernozems, famous for its fertile and productive black soils, is a broad belt throughout which such a combination of physiographic conditions remains relatively uniform. This belt does not stretch entirely across the continents, being interrupted in various places by the mountainous regions and the coastal regions strongly affected by the influence of a marine climate, in neither of which normal chernozems can be developed. It may be assumed that in the western United States chernozem soils would occupy most of Washington and Oregon but for the Cascade Range.

The Cascades, standing as a barrier across the path of the prevailing westerly winds from the Pacific Ocean, create on their western slopes and foothills an independent, exceedingly humid west-coast natural province and cast a dry climatic shadow over the part of Washington and Oregon east of the mountains. The exceedingly high humidity of the humid province, which stretches from British Columbia into the northern part of California, coupled with a luxuriant forest vegetation composed mainly of evergreens, creates an environment that has caused the development of a group of soils fundamentally and strikingly different from the chernozems.

On the other hand, a meridional belt of arid semidesert reaching far northward extends through the entire region covered by the dry climatic shadow east of the Cascades. This is a northward peninsula-like protrusion of another great horizontal zone, south of the chernozem zone. If the Cascade Range and the coastal mountains did not exist, this zone would hardly extend as far north as the northern boundary of Utah and Nevada and would reach the coast only in the southernmost part of California. This region is occupied by the very light gray, grayish-brown, or brown soils similar to those of Ritzville, Wheeler, and many other series, which form another great group of light-gray and brown soils of the semidesert—"serozems" and "burozems."

This geographical distribution of the principal soil groups of Wash-

ington and Oregon may be described as the Cascadian inversion. It is a replacement of the natural latitudinal extension of the horizontal zones by a series of individual belts running north and south parallel to the main axis of the Cascades.

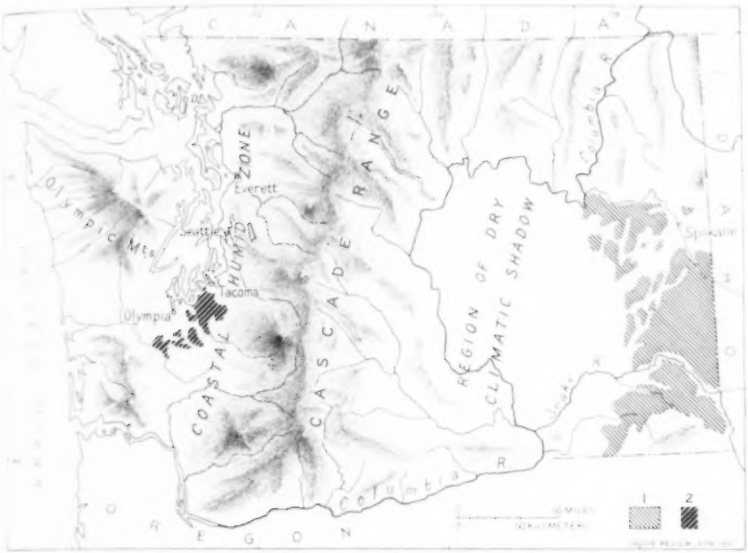

FIG. 1—Map showing: 1, the distribution of the chernozem soils of eastern Washington (after Marbut); 2, the black prairie soils of the Olympic reinversion. Scale 1 : 5,400,000.

GEOGRAPHICAL REGIONS AND BIOLOGICAL PRESSURE

This inversion creates a very uneven distribution of biological pressure in the region. Biological pressure expresses a ratio of the amount of living matter to a given square unit of the surface area. Living matter, or a sum total of the bodies of living organisms—plants, animals, insects, microörganisms, etc.—is a peculiar geochemical surface formation; its existence is limited by rather narrow physical parameters, and its natural geographical distribution over the earth's surface is a function of geophysical environment and especially of climate. Some regions whose physical conditions are optimal for biochemical activity harbor conspicuous geographical congestions of living matter, whereas their antipodes must be regarded almost as virtual biological vacuums. One may assume the existence everywhere of a certain natural balance between the physical capacity of any given natural region and the degree of its saturation by living matter and its activity. The latter, designated as a biological pressure, whether it is measured by weight or by volume of living matter to a square unit of the surface area or by number of species, is the

FIG. 2—Mount Baker. A vertical zone corresponding to the Polar horizontal zone.

most spectacular and characteristic feature of every individual geographical region, and it imposes its influence upon the most fundamental characteristics of every one of the so-called great or zonal types of soil.

No exact data concerning the actual distribution of living matter in the region under consideration are available, but a fairly close parallelism between the distribution and the relative amount of rainfall

FIG. 3—Tatoosh Range near Mt. Rainier. Alpine landscape near timberline on the high Cascades.

FIG. 4—The forest of the West Coast humid belt.

allows one to judge the relative degrees of pressure on the basis of the differences in humidity. The coastal zone, with its 60 to 100 inches of rainfall and its luxuriant, almost unparalleled forest, is a province of exceedingly high biological pressure (Fig. 4), whereas the region covered by the dry climatic shadow east of the Cascades is a province of almost equally low pressure (Fig. 5). Farther east, parallel to a diminution of the depressing influence of the shadow,

FIG. 5—Semidesert along the dry climatic shadow east of the Cascade mountains.

the biological pressure rises again to a level close to normal for a fairly good development of chernozem soils. Each grade of this pressure has its own geographic centers in which it attains its maximum and from which it gradually decreases toward the margins of its zones of influence.

Vertical Zonality

An old conception of the inversion of the horizontal soil zones has been developed from an assumption that changes in altitude lead to replacement of the normal horizontal zones by vertical zones. It has been, and to a certain degree still is, believed that the sequence of vertical zones from the lower to the higher altitudes is the same as the sequence of the horizontal zones from the tropics toward the polar regions. The sequence of the normal horizontal zones in a reverse direction is as follows: Polar, Tundra, Podzol, Chernozem, Chestnut Brown, Gray Semidesert, Desert. Accordingly, if the altitude were appropriate, one would expect an occurrence of any zonal complex within the general geographic margins of another zone in the shape of isolated "islands" or of irregular peninsula-like protrusions. Of this there are many striking examples; for instance, perfectly developed podzols are found at high altitudes in central Utah and Colorado. Generally speaking, however, and so far as soil geography is concerned, the existence of vertical zonality and especially its parallelism with horizontal zonality seem exaggerated. The character of the natural environment in mountainous regions is such that a repetition or a reproduction at different altitudes of the conditions of the normal horizontal zones is hardly possible.

The peaks of the Cascades reach the altitudes of everlasting snow (Fig. 2), which correspond to the Polar horizontal zone, and the range extends through the latitudes of the Chernozem zone. Therefore an inversion of the Chernozem zone by the vertical zones might be expected to bring about a liberal development of podzolic soils, similar to that in more northern latitudes. This is not the case. So far the true podzols, or even the more or less clearly podzolized soils, have not been found anywhere in the Cascades. Apparently the Cascadian inversion of the Chernozem zone has not the character of the northward extension of the Podzolic zone, according to the laws of vertical zonality, and is not similar to the inversion of the Chernozem zone in Russia by the Ural Mountains. A possible explanation is that the rise in altitude, to the requisite amount for existence of the vertical podzolic zone, is completely overpowered by the influence of the Cascades in their role of climatic barrier especially as regards precipitation. Each of the great soil zones has its own climatic optimum and also a certain climatic minimum and maximum, or natural limits beyond which its existence and the development of its products are impossible.

The Ural Inversion Contrasted

The geographical location of the Cascades at a short distance from the Pacific coast, the general direction of their main axis just across the path of the prevailing winds, and their altitude of several thousand feet above sea level work together for the maintenance of a rather sharp demarcation of the strikingly different physiographic provinces. The Ural Mountains of Russia are unlike the Cascades. The average elevation of the Urals is considerably lower; they extend through the broad plains of the continent at a great distance from the coast; and—which is especially significant—their main axis, although it has the same meridional general direction, does not run parallel to the nearest shore line (of the Arctic Sea) but on the contrary is almost at right angles to it. Consequently there is not a marked difference in general climatic conditions east and west of the ridge to interfere with or overshadow the possible expression of vertical zonality. This expression is helped also by the fact that the Ural Mountains are characterized by much broader, smoother, and more gradual slopes than the slopes of the Cascades. The Ural inversion of the Chernozem zone actually divides it into the West Siberian and European Chernozem provinces by a southward protrusion of the northern Podzolic zone, as is clearly shown on the excellent soil maps of the Soviet Union.

The average amount of the very unevenly distributed rainfall in the west-coast climatic zone of North America approaches that of the humid provinces of the tropics. This suggests a possibility of a general trend of the soil-forming processes along the lines of laterization, at least to a certain degree. The high precipitation is not, however, coupled with tropical temperatures, and the luxuriant forest vegetation, whose biological pressure is probably not less than that of the tropical jungle, is composed chiefly of conifers, which have a well established reputation of being the best "podzolizers," conditions that obviously prevent true and successful laterization.

West-Coast Region an Independent Zone

A combination of all these factors distinguishes the west-coast region as an independent zone of its own: its soils cannot be considered as members of any of the definitely established great soil groups. The qualification seems necessary because of the presence in the last Glinka classification of the ill-defined group of Red and Yellow soils of moderately warm latitudes. This group is included by Glinka in his "Lateritic Type of Soil Formation," but so far we know little about these soils beyond their color names.

The soils of the west-coast zone within the borders of the state of Washington form several distinct groups. The major groups are

the three that can be designated as Yellow-Brown, Pink-Brown, and Black-Brown. So far as area is concerned, the first and second are by far the most important. They can also be designated as a northern and a southern group respectively. Although the third group occupies hardly more than 1 per cent of the total area, the genesis of this small group is the most interesting.

Yellow-Brown and Pink-Brown Groups

Both the Yellow-Brown and the Pink-Brown groups are composed of typical forest soils, each with its individual types, its own intrazonal associates, and its own affiliated azonal soils. Being members of one physiographic province, these groups possess certain characteristics in common. Among these are the far more effective modulation of the initial parent materials into the soil horizons by the subterranean agents of the biosphere, especially roots, than that which can be expected from decomposition of the organic residue on the surface; a rather slow general turnover of the pedobiological cycle due to the fact that the bulk of living matter passes through the long-lived trees; and a rather scanty herbaceous vegetation. By far the greater part of the organic residue consists of decayed wood, which decomposes very slowly and evidently without the stage of formation of the dark-colored true humus. A very low content of dark humus in the solum is another characteristic of these soils. To this may be added a slightly acid reaction and a complete lack of carbonate accumulation, in either the solum or the parent materials.

On the other hand, each group has certain characteristics in which it differs from the other. The most fundamental of these is a considerable difference in the geological age of the parent materials and consequently of the soils themselves. The Yellow-Brown, or northern, group is composed mostly of soils developed from the glacial deposits of the Puget Sound moraine and their postglacial derivatives and from moraines deposited by the local Cascadian glaciers. The age of certain residual soils affiliated with this group is presumably the same, because it is hardly possible that the period of deglaciation of the western slopes of the Cascades was much earlier than that of the final retreat of the Puget Sound lobe of the main continental glacier.

The main body of the Pink-Brown, or southern, group lies roughly south of the terminal moraine that marks the southernmost extension of the Puget Sound glaciation. Some glacial deposits found in the southern region belong to a period earlier than those of the Puget Sound (Admiralty Inlet), and much of the area never was glaciated. Several isolated moraines deposited by the local Cascadian glaciers are exceptions. St. Helens moraine is one of these. These local deposits are most likely contemporary with the other Cascadian moraines and give rise to soils similar to those of the northern group.

The advanced age of the parent materials of the southern group is clearly shown by greater weathering and considerably stronger oxidation. Almost all these deposits are characterized by the rather bright yellow, brown, pink, or red color that continues to a considerable depth below the surface. This feature serves as the main morphological distinction between the soils of the two groups. The parent materials of the northern group are typically gray, olive gray, or dull bluish gray, and only the horizons of the solum, which averages about 2 or 2½ feet in thickness, acquire the bright yellow-brown color that has suggested their regional designation. The horizons of the solum of members of the southern group, on the other hand, are characterized by a conspicuous pink, red, or purple color that may be due to stronger oxidation and a certain degree of hydration of the parent materials.

The slight difference in climatic conditions, due to the difference in latitudes, is overshadowed by this influence of unequal age. Some features, however, can be credited to it, for instance the somewhat darker color of the upper horizon of the solum of the Pink-Brown soils. This horizon hardly ever exists in the soils of the northern group but averages about 10 or 12 inches in thickness in the soils of the southern group. The color denotes a somewhat higher content of humus in the Pink-Brown soils, which, in turn, suggests a possibility of some difference in the process of decomposition of organic residue and also in its chemical composition (possibly caused by the slight increase in the proportion of herbaceous plants). Moreover, this horizon of the Pink-Brown soils is characterized by a fairly well developed fine or medium-lumpy structure, which is completely lacking in the soils of the northern group.

These slight morphological differences, although less conspicuous than those deriving from differences in geological age, are nevertheless more significant for an understanding of the Pacific Coastal zone as an individual geographical unit. This zone stretches in a nearly meridional direction for more than a thousand miles; its width ranges from less than one hundred miles to hardly more than two hundred. Its main axis extends in a direction almost at right angles to the axes of the great continental horizontal zones, and it crosses no fewer than three of these zones. In the north, somewhere on the coast of British Columbia, it appears and crosses the Podzolic zone; through Washington and Oregon it inverts the Chernozem zone; and its southern part extends far into the Semidesertic zone of the light burozems. The question naturally arises whether the factors that created this meridional coastal zone as an individual physiographic unit are strong enough to eliminate completely all individual characteristics that one could expect to find in different latitudes.

Each of the three horizontal zones crossed by the coastal zone is characterized by a particular type of climate; each has its own range

of annual rainfall and temperature and its own characteristic distribution of these through the year. In addition, each zone is characterized by a different grade of biological pressure, which is the most powerful factor in soil building. In this respect the three zones, Podzol, Chernozem, and Semidesert, represent the three principal types of soil formation: woodland, grassland, and brushland respectively.

The main features of the meridional Coastal zone are the exceedingly high rainfall and the correspondingly high biological pressure. The amount of rainfall remains throughout the full extent of the zone considerably higher than the normal amount for the most humid of the horizontal zones it crosses. The same is true of its biological pressure, and this is responsible for the geographical integrity of the Coastal zone, despite the fact that it extends across three fundamentally different latitudinal zones. Nevertheless there are changes of soil characteristics in a meridional direction that reflect the change in latitude, especially south of the Columbia River, in the portion of the Coastal zone extending through western Oregon.

FIG. 6—Typical profile of the prairie soil in western Washington.

THE BLACK-BROWN SOILS: PRAIRIE ISLANDS

The third major group of soils in western Washington is strikingly different in almost every respect from the other two groups. An outstanding characteristic of the soils of this group is the very dark brownish-gray or black color of their upper horizon, which in most places is not less than a foot thick (Fig. 6). This group does not include the dark-colored hydromorphic intrazonal soils associated with the other major groups but only the normal soils of the open prairie.

The area occupied by prairies in western Washington does not form a continuous body but occurs in several scattered tracts or isolated islands. The largest and most conspicuous of these islands are south of Tacoma and south and east of Olympia (Fig. 1). They range in size from less than one square mile to several square miles, and most of them are on the broad and generally flat outwash aprons and the various terraces built up of loose, unassorted, though distinctly stratified, fluvioglacial deposits.

The islands of prairie are naturally open and evidently were not

occupied by forest vegetation for a long period. Probably they have remained open continuously since their formation. There are, however, rather clear indications that forest vegetation is forcing its way on the prairie. The outer parts of several large islands and some small ones are sparsely covered with oak, which is followed by fir (Fig. 10).

The soils universally developed on these islands are a typical product of the grassland environment. In spite of their very dark, not infrequently black, color, these soils do not belong to the group of true chernozems but are classed as an independent group of prairie soils. The principal difference between the prairie soils and the true chernozems is the lack in the prairie soils of a horizon of carbonate accumulation, which is one of the fundamental characteristics of the chernozems. On the other hand, several fundamentally important characteristics reveal the close relationship between these two groups: a striking similarity in the morphological profiles of both, namely a strong development of the horizon of humus accumulation, due to their being products of the grassland environment; a rather high content of humus in this horizon, which gives it its very dark brownish-gray or black color (Fig. 6) and, not infrequently, a specific structure; a particular chemical composition of their humus, due to its formation from the residues of herbaceous plants; a specific arrangement and velocity of the general pedobiological cycle; and several other characteristics. All these indicate that the prairie soils of western Washington are genetically related to the dark soils in the eastern part of the state. They may be regarded as a transitional link between the true chernozems and the most weakly podzolized meadow soils of the forested belt.

Secondary Inversion of the Olympic Mountains

The reappearance of these soils and the existence of the tracts of prairie amidst the evergreen-forest empire of the west-coast humid zone indicate a further implication of the zonal inversion. Several natural factors combine their influences to create the necessary environment. One is a secondary inversion of the west-coast humid zone created by the Olympic Mountains and probably some other coastal mountains.

The Olympic Mountains play a role similar to that ascribed to the Cascades. Located at some distance west of the Cascades, on the main path of the oceanic moisture-bearing winds, this massif arrests some of the moisture carried by the westerly and northwesterly winds and itself casts a climatic shadow, which stretches in a general southeastern direction. As the Olympic Mountains form an isolated mass not large in extent, their influence is correspondingly limited.

The Olympic inversion does not cause a reappearance of the semidesert similar to that of the central part of the state, but it is sufficient

FIG. 7—A "prairie island" north of Centralia (south of Olympia) in western Washington.

to neutralize the excessive humidity of the coastal zone and to cause a reappearance of the prairie which is closely related to the prairies of the would-be continuous horizontal zone.

COMPLEXITY OF CAUSES OF PRAIRIE

The significance of the Olympic reinversion should not be overestimated. Alone it would hardly be sufficient to protect the narrow

FIG. 8—Along the border of the prairie island. Sparse growth of fir.

FIG. 9—"A mound prairie" near Tenino (south of Olympia), Washington. A peculiar microrelief of the prairie found in the close vicinity of terminal moraine.

tracts of open prairie in the midst of the forest empire: but its influence is coupled with other geographic factors. Among these may be assumed a general decrease of the biological pressure of the Coastal zone in a direction from its geographic centers (or points of maximum) toward its natural margins. The geographic centers of pressure of the Coastal zone, its area of optimum, so to speak, naturally must be located

FIG. 10—A growth of oak and fir along the border of an open prairie island.

somewhere in the lower part of the western slopes and in the adjacent foothills. From these centers the pressure of the zone gradually decreases to the east and to the west, until it reaches a grade typical for the other zone.

The coastal belt in the northern part of Washington, as far as about the latitude of Everett (48° N.), is rather narrow and is completely under the influence of the Cascades. South of this latitude a much greater distance separates the Cascades from the coast, and the influence of the high biological pressure centered somewhere near the foot of the mountains ought to be considerably diminished at some distance from the centers. The probable lowering of the biological pressure, as may be estimated by the amount of rainfall, is not very great, however; and, even when it is coupled with the influence of the Olympic shadow, it would hardly be sufficient for a complete reinversion of the Coastal zone. The average amount of rainfall still remains considerably higher than normal for the typical prairie regions. There must exist some other factors capable of neutralizing the influence of the excess of moisture. Such a factor is found in the physical character of a particular type of parent material from which the prairie soils of western Washington are developed. It has been mentioned above that most of the tracts of prairie here are confined to the plains and terraces built from the loose and porous fluvioglacial deposits. These deposits usually extend to considerable depth and are composed of unassorted gravel, pebbles, and sands (Fig. 6). Not infrequently the gravelly strata have very little, if any, of the interstitial fine-textured material. This parent material has an exceptionally low moisture-holding capacity, and this in turn serves as a counteragent to a relatively high amount of rainfall.

It has indeed been suggested that this factor alone is sufficient to prevent natural forestation of the tracts of prairie. This does not agree with the facts. Fluvioglacial deposits of this same character occupy a territory much wider than that occupied by prairie. Much of this territory is forested, and a forest vegetation obviously does not suffer from a deficiency either of moisture or of other nutrients.

It is a combination of the factors mentioned and a probable coöperation of some others that make a development of prairie soils in this physiographic province natural and inevitable and lead to an assumption that the occurrence of these soils here signifies a reappearance in western Washington of the great horizontal zone of black soils.

The great natural zones are nowhere separated by sharp and permanently fixed boundaries. This is especially true of the wooded and grassland zones, the boundary between which is a result of the never-ending biological battle between the different types of vegetation. Between a continuously open steppe or a prairie on one side and a dense forest on the other is a transitional belt of "parkland."

At first isolated small groves of the most resistant trees struggling for life are found scattered here and there on the open prairie; gradually the number of these trees increases, as does the size of the groves, until they join, and only isolated tracts of open land are left amidst the forest. These tracts decrease in size and number and finally disappear. Each stage corresponds to a particular equilibrium between the factors working for different zones. The stage in which only isolated tracts of prairie are found scattered in the woodland corresponds to a balance of natural conditions very close to the margin for existence of the prairie. This is what is found in western Washington.

MIGRATIONS OF HUNGARIAN PEASANTS

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MODERN migration may be classified as plantation, pioneer, and urban, according to the economy into which additional population elements are being introduced. The movement of Hungarian peasants from their native habitat is significant in that inside the cultural as well as the political limits of the migrants' homeland all three general types of migration are taking place. Emigration of Hungarian peasants to other countries, however, has been largely, though by no means entirely, of the urban type. The sudden change from the environment of peasant communities to that of highly industrialized cities has brought the emigrants into close contact with other cultural groups and has created for them new problems of economic and social adjustment.

The Peasant in His Native Habitat

The tendency to migrate has not characterized all strata of Hungarian society equally. During recent decades mobility has been most marked among the peasantry, which itself is made up of the following social and economic classes:

1. Servants on the landed estates (*uradalmi cselédek*). Members of this class occupy a relatively secure and permanent position. Their children normally remain on the same estate on which the parents' lives have been spent. This class contributes few to the number of migrants unless the system of latifundia itself is seriously disturbed, as after the agrarian legislation of 1920 and 1924. When the landed estates were reduced in size, many of the *uradalmi cselédek* were discharged by the landlords and thus were compelled to migrate.

2. Landless men or cottagers (*zsellérek*).[1] These are usually the descendants of those serfs who failed to share in the "parceling of land" that followed the emancipation of the serfs in 1848. The *zsellér* of today owns no land except the site on which his house is built. He must secure his livelihood by working on the land of others. He labors as a servant, either on the estate of some landlord or on the holdings of the wealthier peasants.

3. "Dwarf landowners" (*törpe birtokosok*). Members of this class have holdings so small that a livelihood cannot be secured without supplementary income.

4. Small farmers (*kisgazdák*), who own enough land to provide a livelihood for themselves and their families. This class forms the

[1] A. J. Patterson: The Magyars: Their Country and Institutions, 2 vols., London, 1869. Vol. 1, p. 323.

apex of Hungarian peasant society. Although constituting numerically only a small part of Hungary's agricultural population, it has played so important a role in the social and political life of the country that attention is usually confined to it alone in any discussion of the Hungarian peasantry.[2]

The economic independence of the small-farmer class is attained usually by those who own from ten to fifty cadastral acres or more. However, as the distinction between the dwarf landowner and the small farmer is popular rather than official and statistical, wide variations occur in different parts of Hungary. Factors such as the standard of living in a particular region and the fertility of the soil on a particular holding determine whether marginal cases should be included among the economically dependent dwarf landowners or among the independent small farmers. For example, in Tófalu, Heves County, a person owning even six acres of good arable land would be considered a *kisgazda*, since the peasants of this commune are satisfied with a very meager livelihood. The peasants of Decs, Tolna County, on the other hand, do not consider anyone a *kisgazda* who owns less than a hundred acres of good arable land. The cultural heritage of the people of Decs demands a standard in housing, furniture, clothing, and farm equipment that the people of Tófalu would never dream of possessing.

As a result of the economic independence and high social status of the independent small farmers, very few members of this class are found among the migrant population, with the exception of the more prosperous *tanya* settlers. Through the increasing practice of birth control by members of this class, their numbers tend to remain fairly stationary.

5. The "peasant specialists in trade and industry." As a supplementary class to the peasant society of the smaller communes there are certain specialists—blacksmiths, carpenters, bootmakers, and others—who are sons of peasants, intermarry with peasants, and, like other peasants, own and work small landholdings. In the larger cities the specialist in trade and industry is much farther removed from the peasant and under no circumstances could be included in the class with him.

Although the present status of these specialists in the small communes is actually higher than that of the small farmers, their origin is usually lower. Many of them are the sons of *zsellérek* and were apprenticed to the village blacksmiths or carpenters as an adjustment to the landless condition of their families. By means of occupational mobility these persons have sought a niche for themselves in the communes in which they were born. Other sons and daughters of the landless and the dwarf landowners have sought an adjustment

[2] Weis István: A Magyar Falu, Budapest, 1931, pp. 29–30.

through spatial rather than occupational mobility and have migrated, either to other parts of Hungary or to other countries. The mobility involved in the change of occupation by these village specialists has "broken the cake of custom" to such an extent that members of this class are among the most eager to migrate in order to seek better economic opportunities elsewhere.

FIG. 1—Plan of commune of Bak, Zala County (reproduced from Gönczi Ferenc: Göcsej, Kaposvár, 1914, p. 398). Reference: 1, row of houses on both sides of the single street; 2, *beltelek* or inner settlement (each house has a strip of land attached with the exception of a few houses of the *szellérek*); 3, arable land of the *kültelek*; 4, communal pasture; 5, communal forest; 6, communal meadow; 7, *puszta*, or residence quarters of *uradalmi cselédek* of neighboring estate; 8, forest belonging to neighboring estate; 9, brick kiln belonging to neighboring estate; 10, communal fallow land. The area is 1353 cadastral acres.

The native habitat of Hungary's peasantry[3] is the village (*falu*), which denotes the administrative units of the small (*kisközségek*) and large (*nagyközségek*) communes. Despite great differences in the size and form of the communes, all have one characteristic in common: each consists of a nucleus surrounded by a periphery. The nucleus, or "inner settlement" (*beltelek*), is made up of the houses of the inhabitants and small adjacent gardens; the periphery, or "outer settlement" (*kültelek*), includes the rest of the communal territory—arable land, meadows, pastures, vineyards, and forests (Fig. 1).

The wealth or poverty of a Hungarian village is determined to a very large extent by the amount of its *határ*,[4] that part of the peripheral area that is owned by the peasants themselves. In this sense the term *határ* does not include the landed estates, which form enclaves within

[3] An exception is found in the *uradalmi cselédek*, who live in settlements on the estates on which they are employed. These *uradalmi majorok* or *puszták* are without the administrative rights of the commune.

[4] The term *határ* denoted originally a limit or boundary. Then it came to mean the entire territory inside the boundaries of a commune. The peasantry, however, in all parts of Hungary use this term for the communal territory outside the *beltelek* exclusive of the manorial estates. Although this peasant use of the term has not been accepted by Hungarian lexicographers, it expresses the peasant's feeling that the estates do not belong to the communes.

the commune and interfere with the communal pattern of settlement. Communes in which the *határ* is large in proportion to the number of inhabitants tend to have a relatively high percentage of independent farmers among their householders. In such communes the supply of agricultural day laborers will not be so great as the demand for their labor. Consequently comparatively little migration takes place. The opposite is the case with communes in which the *határ* is small in proportion to the number of inhabitants. In these communes the supply of day laborers exceeds the demand for their labor on the part of the small farmers. Hence these laborers are compelled to seek employment on the landed estates or to migrate elsewhere.

Seasonal Movement to the Landed Estates

Superimposed on the pattern of peasant communes in Hungary is a unique aggregation of landed estates, uninhabited plains under the administration of "peasant cities," and industrialized urban areas. Each of these represents a different type of economy to which migrating peasants must adjust themselves. The seasonal migration of agricultural laborers to the landed estates is an example of the "plantation" type of settlement.[5] Although the landed estates give permanent employment to several peasant families who live on them, additional laborers are needed at special times, such as during harvest. In many places they can be furnished by the adjoining communes. Such villagers go each day to their work on the estate and return home to the village at night. In some places, however, the local supply is insufficient. Either the estate is large, or the number of landless men in the neighboring communes is small, or the people of these communes demand higher wages than the estate is willing to pay. In such cases laborers (*summások*) are imported from communes in which the population tends to specialize in "plantation labor." Many of these laborers come from the Matyó communes of Mezőkövesd, Tard, and Szentistván, in Borsod County.[6] A contract is made between the estate and an agent representing the migrants. Temporary barracks are erected on the estate to house the migrants during the weeks or months of their employment, and during this period they tend to remain in virtual isolation owing to the well marked social distance that separates them from other laborers on the same estate. As in other plantation economies, the landed estates of Hungary are integrated with world markets, and consequently their demand for labor fluctuates with the conditions of these markets. When adverse economic conditions limit the employ-

[5] Although this meaning of "plantation" is usually restricted to large estates in tropical and subtropical climates, it may conveniently be used here for estates specializing in a single crop, a characteristic of the plantation proper.

[6] Cf. E. D. Beynon: Isolated Racial Groups of Hungary, *Geogr. Rev.*, Vol. 17, 1927, pp. 586–604.

ment of migrant laborers on the estates, the surplus population of these communes must make an adjustment through migration either to cities in Hungary or to other countries.

Pioneer Settlement: The Tanya Movement

In the case of Hungarian peasants, pioneer settlement, as it may be termed, takes place usually inside the administrative limits of the

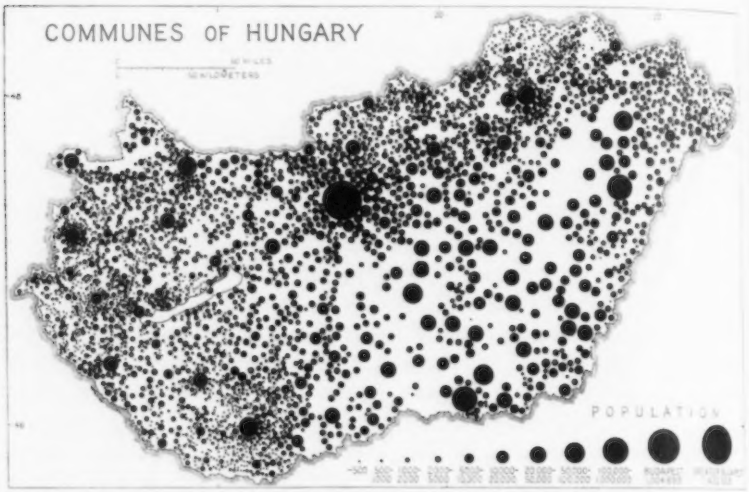

Fig. 2—Cartogram showing the distribution of the communes of Hungary according to size. Reproduced from a map by Dr. G. Thirring (see footnote 8).

peasant's native commune. By this short-distance migration he changes his residence from the area of inner settlement to the peripheral area. Such migration has been of two principal types: the *tanya* movement and the settlement resulting from the agrarian reform. In the former the peasant moves to the *határ*, the communal land owned by the peasants themselves. In the latter the peasant settles on a holding taken from the large estates that impinged on the communal land. In both this migration is almost entirely a "back to the land" movement of agriculturists who have exchanged the more "organic" social structure of the commune for the more "segmentary"[7] economy of isolated farm homes.

The map of the communes of Hungary[8] shows that the Alföld has a pattern of settlement very different from that in the northern and western parts of the country. In the north and west communes

[7] The terms "organic" and "segmentary" are used in the sense adopted by Émile Durkheim in "De la division du travail social." Paris, 1902. The pioneer farmer settled in the peripheral area is not only farmer but also builder, miller, smith, and shoemaker.

[8] See the map of the communes of Hungary prepared by Dr. G. Thirring for *Magyar Statisztikai Szemle*, Vol. 10, 1932, Fig. 2, facing p. 14.

are placed close to one another; in most places a constellation of small communes is grouped around a large commune, or city. On the Alföld, however, there are wide, open spaces devoid of communes. At long intervals there are very populous communes; but, unlike the nucleuses of settlement in the north and west, these "peasant cities" are not surrounded by constellations of smaller communes, though the ruins found on the Alföld indicate that before the Turkish invasion the plain was divided fairly regularly among small cell-like communes. The inhabitants of the smaller villages fled before the roving bands of Turkish spahis and settled in the more populous communes, which already had enjoyed a dominance as market towns of communal constellations. These market towns increased greatly in size through the incoming of the fugitives; thus they were able to secure favorable terms from the Turkish pashas and protection from the depredations of wandering bands. Meanwhile the entire territory of the smaller communes, including the sites of the ruined villages, became part of the communal land of the market town. Thus the city of Debrecen has under its administration an area of 957 square kilometers, which embraces the territory of 11 to 30 abandoned communes.[9] In consequence of this population movement the Alföld was given over almost entirely to a pastoral economy. There was virtually no crop cultivation whatever outside the immediate environs of the "peasant cities." The herds and flocks of the citizens were pastured together on the unfenced and undivided reaches of the *határ*.

The transition to an agricultural economy during the latter part of the nineteenth century necessitated the "parceling" of the communal land. In the division of the former ranch lands no uniform policy was followed: each commune or city sold or leased parcels of land at its own time and in its own way. There were two common features, however, in the policy of virtually all the Alföld communes. Only citizens of the commune itself were given the opportunity to "stake claims" in this "pioneer belt of Hungary" which was being opened up for agriculture. The parcels claimed, however, were not intended for use as "homesteads." Almost every commune issued stern ordinances against the building of permanent homes on the *határ*. Citizens were commanded to reside in the inner area, in order that they might perform their civic and religious duties.

In spite of the prohibitions of the communal authorities citizens whose holdings were distant from the core erected on the *határ* temporary structures in which they lived during the summer. These

[9] Ecsedi István: A Hortobágy Puszta és Élete, Debrecen, 1914, pp. 84–94. Louis Zoltai: Debrecen and the Hortobágy Puszta, *Sociological Rev.*, Vol. 16, 1924, pp. 336–343, holds that there were 11 of these abandoned villages, in six of which there had been either a church or a chapel. In his publication, "Eltünt Pusztafaluk Debrecen Határában" (*Föld és Ember*, Vol. 4, 1924, pp. 65–74; reference on p. 65), Ecsedi states that at least 25 now abandoned communes had flourished in the *határ* of Debrecen between the twelfth and the fourteenth centuries.

"summer homes" of agriculturists were called *tanyák*, a term that had been applied to the temporary hovels used by the herdsmen of the plains during stormy weather. At first only those citizens who were men of substance settled on the *határ*, since only such men could maintain two homes.

Since the beginning of the twentieth century the word *tanya* has assumed an entirely new importance. The "two-house system" has

TABLE I—"TANYA" POPULATION OF HUNGARY, BY COUNTIES, IN 1920*

COUNTY	AREA (*Sq. km.*)	TOTAL POPULATION	PERCENTAGE OF TOTAL
Csongrád	3,410	322,383	35.79
Békés	3,670	311,109	34.62
Hajdu	3,343	271,506	29.39
Jász-Nagykun-Szolnok	5,259	387,225	28.83
Csanád-Arad-Torontál	1,998	167,439	26.95
Szabolcs	4,569	333,683	25.03
Bács-Bodrog	1,628	115,223	20.54
Bihar	2,754	161,061	15.05
Pest-Pilis-Solt-Kiskun (excluding Budapest)	13,161	2,163,430	13.50
Szatmár	1,731	109,419	12.41

*Compiled by Gesztelyi Nagy László in "Magyar Tanya," Kalocsa, 1928, pp. 51–53, based on data in *Magyar Statisztikai Szemle*, Ser. 1, 0000, pp. 308–311. According to this estimate the total number living on the *tanya* in 1920 was 896,918.

largely passed away, and the *tanya* has become not a mere summer home but the permanent home of an increasingly large percentage of the population.[10] The wealthy citizens among whom the *határ* had been divided were followed by the communal proletariat, who made no pretense of maintaining two homes. Wherever possible, these people entered the service of the established farmers—the *tanyás gazdák*. Otherwise they attempted to "squat" on the land and lived —and still live—in the most abject poverty.

The problem of the migration to the *tanya* has been of greatly increased significance since the close of the World War, since all the *tanya* settlements remained within postwar Hungary.[11] In the last census before the war the population of Hungary was 20,886,487; in 1920 it was only 7,989,069, of whom about one-fifth (20.5 per cent) lived "on the *tanya*."[12] Although the population of the entire country had increased to 8,683,740 in 1930, the population living "on the

[10] Weis István: A Mai Magyar Társadalom, Budapest, 1930, p. 14.

[11] Professor Magyary Zoltán, director-general of the Hungarian Institute of Public Administration, in the Preface to Kiss István: A Magyar Tanyai Közigazgatás, Budapest, 1932.

[12] The word *tanya* has come to mean the area in which this type of settlement is taking place.

tanya" had increased so rapidly that it constituted 21.8 per cent of the total.[13]

The *tanya* migration has been confined to the 10—formerly 12—counties that constitute the Hungarian Alföld.

As migration "to the *tanya*" has been everywhere the concern of the communes rather than of the counties, it happens that several of the communes of the Alföld have a much higher percentage of their population living "on the *tanya*" than any of the counties has. The corporate city of Kiskunhalas, in Pest-Pilis-Solt-Kiskun County, has an area of 112,195 acres and a population of 26,088, of whom 52.3 per cent are *tanya* residents. Kecskemét, with an area of 163,237 acres and a population of 73,109 persons, has 50.9 per cent living "on the *tanya*." Debrecen, with an area of 166,284 acres, has 48.5 per cent of her 103,186 inhabitants "on the *tanya*."

Although the *tanya* settlers remain under the administrative control of the communal authorities, their migration "to the frontier" has meant for most of them a more or less complete break with their accustomed pattern of life.

Migration Resulting from the Agrarian Reform

The World War was followed in Hungary by the Land Reform Laws of 1920 and 1924, which constituted a capital levy whereby owners of estates of more than 1000 cadastral acres were compelled to pay their tax in land. In this way the state obtained about a million and a quarter acres of land.[14] Provision was made for the acquisition of this land by two classes of peasants:

1. Landless men (*zsellérek*) with certain qualifications, such as honorable war record, war disability, "irreproachable moral character," Hungarian citizenship, and proof of hostility to communism. Such persons were able to procure holdings of one to five cadastral acres.

2. Dwarf landowners (*törpe birtokosok*) who were enabled, by receiving six or seven additional acres, to gain the status of small farmers. This "parcellation for supplementing small farms" did not affect the pattern of settlement, since the dwarf landowners continued to occupy their homes.

The former landless men, on the contrary, usually migrated from the core of the commune to the scattered holdings in the peripheral area that they received. Almost all these holdings were of inadequate size for an independent livelihood. Indeed, it is because of this fact

[13] Percentages compiled by Dr. Louis Thirring in *Magyar Statisztikai Szemle*, Vol. 8, 1932, pp. 1044–1062. Dr. Thirring's figures for *tanya* settlement in 1920 are virtually double those of Gesztelyi Nagy László, used in Table 1, but Thirring's work is officially endorsed by the Hungarian Statistical Office (Office Central Royal Hongrois de Statistique).

[14] Nicholas de Matthyasovszky: La réforme agraire en Hongrie, *Rév. Écon. Internatle.*, 22nd Year, Vol. 3, 1930, pp. 291–303.

that the Hungarian Land Reform Law has received its most severe criticism.

A great defect of the Land Reform is that highly cultivated lands have come into the possession of men without capital, who do not understand agriculture and who are too poor to buy agricultural implements. They have no animals, and they are unable to fertilize the land. The result is that many of the new "landowners" have sunk into virtual slavery. They enter into service with richer peasants, who work their land and harvest their crop. These richer peasants charge extortionate prices for doing anything for the new farmers . . . The new farmer naturally cannot pay in money; he is forced to pay in labor. The rich peasant places a very low value on his neighbor's toil. The poor man is compelled to work nearly all year on the rich man's farm in order to pay for the plowing of his own little farm. For the harvesting, he is forced to pay a large percentage of his produce. The poor man's lot has become harder since the Land Reform.[18]

TABLE II—COMMUNES OF THE AREA OF POSTWAR HUNGARY ACCORDING TO SIZE

CLASS OF COMMUNE (*Population*)	NUMBER OF COMMUNES			PERCENTAGE OF TOTAL POPULATION		
	1910	1920	1930	1910	1920	1930
I. Up to 1000	1869	1859	1707	13.2	12.6	10.9
II. 1001–5000 . . .	1382	1390	1440	37.5	35.9	34.2
III. 5001–10,000 . . .	130	130	161	11.5	11.2	12.3
IV. Above 10,000 . . .	85	95	111	37.6	40.2	42.4

CITYWARD MIGRATION

In Hungary the classification of communities for administrative purposes follows a kind of hierarchy: small communes (*kisközségek*); large communes (*nagyközségek*); corporate cities (*rendezett tanáccsal bíró városok*), of which there are 45 in present Hungary; autonomous cities (*törvényhatósági jogu városok*), of which 11 remain in Hungary since the World War. The distinction made between cities of either class and large communes is frequently arbitrary, however, since it is based on historical accident. The census of 1930 shows this anomaly in a striking manner. Baja, an autonomous city, had a population of 27,940. Komárom, a corporate city, had a population of 7567. Szentendre, also a corporate city, had only 7214 inhabitants. On the other hand, communities still ranked as "villages" are Pestszentlőrinc (30,557 inhabitants), Törökszentmiklós (28,396), Szarvas (25,490), and Orosháza (24,941).

To estimate the trends in the rural-urban distribution of population, it is obviously necessary to disregard the administrative classification of communes and to use instead one based on the size of

[18] Translation of an unpublished manuscript by Fekete Imre, overseer of the estate of Kálmáncsa, Somogy County.

population. There appears to have been during recent decades a shifting of the population from the smaller to the larger communes, as is indicated by Table II.

Although the total number of communes[16] in postwar Hungary changed very little during the period 1910–1930, there was a sig-

TABLE III—POPULATION INCREASE OF AUTONOMOUS CITIES OF HUNGARY, 1920–1930*

AUTONOMOUS CITY	POPULATION 1930	NET INCREASE 1920–1930 *Per Cent*	NATURAL INCREASE 1920–1930 *Per Cent*
Baja	27,940	23.0	−0.3
Budapest	1,004,699	8.2	0.0
Debrecen	117,410	13.8	7.0
Győr	50,977	1.9	3.8
Hódmezővásárhely	60,176	−1.2	3.0
Kecskemét	79,505	8.7	11.0
Miskolc	61,465	7.9	4.5
Pécs	61,801	29.9	−0.6
Sopron	35,887	1.8	5.1
Szeged	135,131	9.4	6.1
Székesfehérvár	40,731	4.1	2.4

*Compiled from *Magyar Statisztikai Évkönyv*, No. 38 (N.S.), 1930, Budapest, 1932, pp. 7–8.

nificant change in the distribution of the communes according to size of population. Those with a population of less than 1000 showed a steady decrease both in their number and in the percentage of the total population resident in them. On the other hand, those with a population of more than 10,000 showed a marked increase in both respects. In spite of the fact that the population of the area of *tanya* settlement[17] in the Alföld is included in that of the fourth class of communes and also that a relatively small increase in the population of some communes occasionally changes them from one class to another,[18] this table indicates that there has been a change in the pattern of distribution of the population.

That the trend toward the concentration of the population in the larger communities has resulted from migration rather than from natural increase is also indicated by the census.

The "peasant cities" of Hódmezővásárhely and Kecskemét are largely rural, rather than urban, agglomerations. Although Debrecen

[16] The number of communes in the area covered by postwar Hungary was 3466 in 1910; it increased to 3474 in 1920 but decreased to 3419 in 1930.

[17] The *tanya* movement has seldom involved migration across communal boundaries.

[18] This same difficulty is encountered by the United States Bureau of the Census in dealing with the rural-urban distribution of the population.

and Szeged also belong to the class of "peasant cities," they are rapidly developing a truly urban character,[19] a fact reflected in the excess of net increase over natural increase. The reverse trend in Győr and Sopron is due to the economic hardships suffered by these border cities as a result of the loss of their trade areas through the

TABLE IV—INCREASE OF THE POPULATION OF BUDAPEST, 1873–1930*

DECENNIAL PERIOD	TOTAL INCREASE	MIGRATION *Per Cent*	NATURAL INCREASE *Per Cent*
1874–1880	73,900	92.2	7.8
1881–1890	135,617	86.7	13.3
1891–1900	226,974	70.2	29.8
1901–1910	147,013	55.4	44.6
1911–1920	48,625	100.0	– decrease, 14,387
1921–1930	75,703	99.5	0.5

*Thirring, Budapest Félszázados Fejlődése, p. 28. Data for 1930 are taken from *Magyar Statisztikai Évkönyv*, No. 38 (N.S.), 1930, p. 7.

Treaty of Trianon. The consequent migration from these cities exceeded the natural increase.

Although the census of Hungary indicates that a rural-urban migration is taking place, the characteristics of this migration can be learned only through a more detailed study of individual cities. The size and cosmopolitan character of Budapest and the fact that its increase in population is due almost entirely to migration give it especial significance in relation to the migrations of Hungarian peasants.

Since the formation of the city of Budapest in 1873 through the union of Buda, Pest and Ó-Buda the decennial increase of the population has been as shown in Table IV.

An enumeration[20] made in 1925 of the population of Budapest according to place of birth showed that only 38.46 per cent of the residents of the city had been born there, whereas 37.35 per cent had been born inside the limits of present Hungary outside Budapest. The distribution of the latter group according to county of birth reveals a significant pattern of migration to Budapest from rural Hungary. Of these 359,403 migrants settled in Budapest, 23.73 per cent were born in Pest-Pilis-Solt-Kiskun County, which surrounds Budapest, and 9.37 per cent were born in Fejér County, which adjoins

[19] Mendöl Tibor: Alföldi városaink morfológiája, *Tisia*, Vol. 1, 1936, pp. 3–44 (see note elsewhere in this number of the *Geographical Review*).

[20] Illyefalvi I. Lajos: Budapest Székesfőváros Statisztikai és Közigazgatási Évkönyve, 1930, p. 60.

the metropolitan region of Budapest on the west. Thus almost one-third of all the migrants to Budapest from present Hungary came from the two counties immediately adjacent to the capital.

When the percentages contributed by the remaining counties of present Hungary are taken into consideration, it becomes apparent that other factors than mere nearness are involved in directing the flow of migration to Budapest. The 11 counties of the Dunántúl, or western division of Hungary, furnished 44.19 per cent of all the migrants to Budapest from present Hungary, though in 1930 these 11 counties had only 34.15 per cent of the total population of Hungary exclusive of Budapest. In fact, as Thirring[21] points out, this group of counties has contributed ever since 1880 a disproportionately large part of the population of Budapest. One of the Dunántúl counties, Zala, with a population of 365,120 in 1930, contributed 5.25 per cent of the migrants from present Hungary to Budapest. Csongrád County, with a population of 343,784, is considerably nearer to Budapest than Zala is. Yet Csongrád contributed only 2.61 per cent of these migrants. Another Dunántúl county, Vas, with a population of 274,914, is almost twice as far away from Budapest on the west as Heves County is on the east. Vas, however, contributed 4.65 per cent of the migrants, whereas Heves, with a population of 316,468, contributed only 3.56 per cent. Apparently the greater diffusion of urban culture in the Dunántúl than in the eastern counties of Hungary has been a powerful factor in the differential rate of migration from rural Hungary to the capital. However, a satisfactory study of the migration to Budapest from present Hungary should take into account other types of migration, such as the movement to the *tanya* and emigration to America, since these frequently assume large proportions in counties from which only a few migrants have gone to Budapest.

The character of the migration from rural Hungary to Budapest is indicated by the increasing preponderance of women over men in the sex ratio of the capital. In 1900 there were in Budapest 1022 females to 1000 males; in 1910, 1030 females to 1000 males; in 1920, 1154 females to 1000 males; and in 1930, 1189 females to 1000 males. On the other hand, the census of 1930 showed that with the exception of five cities and one county[22] the ratio of females to males declined in every part of Hungary during the ten-year period 1920–1930. In six of the more rural counties the males now outnumber the females. This migration of the women of rural Hungary was stimulated by the aftereffects of the World War. Great numbers of young women from peasant villages sought and still seek economic and social emancipation in the freer atmosphere of Budapest: *Stadtluft macht frei.*

[21] Thirring Gusztáv: Budapest Félszázados Fejlődése, 1873–1923, Budapest, 1925, pp. 47–48.
[22] *Magyar Statisztikai Szemle*, Vol. 9, 1931, p. 106.

Emigration

During recent years America has been the principal goal of Hungarian emigration. Continental migration, especially before the World War, involved chiefly the non-Magyar residents of Hungary. Oversea migration brought to the United States during the years 1898–1913 about 402,000 Magyars[23] and during the years 1914–1924 about

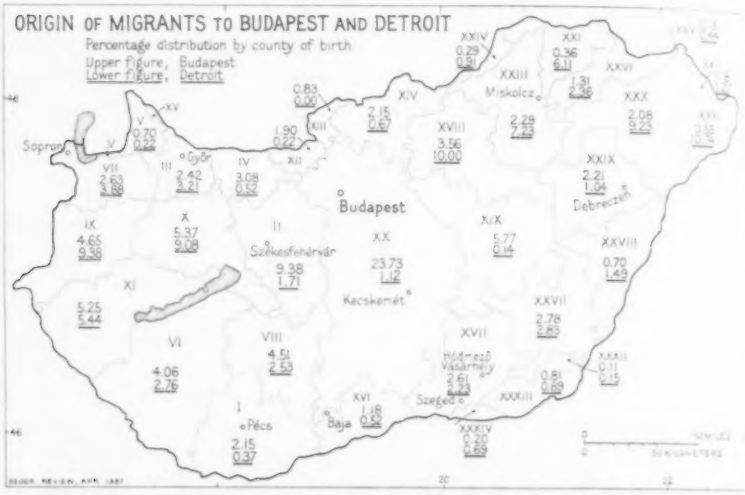

FIG. 3—Map showing the origin of the migrants to Budapest according to the percentage distribution of each group by county of birth. The upper figure shows the proportion of 359,403 residents of Budapest born in the specified county (1925 city census); the lower (underscored) figure shows the proportion of 1341 residents of Detroit born in the specified county (Budapest is excluded).

180,000 more. Owing to repatriation and other causes, the total number of Hungarians in the United States in 1930—both foreign born and native born of foreign or mixed parentage—was only 590,768.

The United States census of 1930 showed that 482,023 persons of Hungarian stock, or 81.6 per cent of the total in the country, were urban. Most of the Hungarian peasants who emigrated to America settled in the cities. The city of Detroit, with a Hungarian population of 22,311 in 1930, ranked fourth among the cities of the United States as a center of Hungarian settlement, exceeded only by New York, Cleveland, and Chicago.

Data on county and commune of origin were obtained from a sample of 1850 Hungarian immigrants resident in Detroit. Of the total number in the sample, 481 had been born in territory ceded from Hungary by the Treaty of the Trianon and 28 had been born in Budapest. Of the remaining 1341 born in present Hungary outside

[23] Gustav Thirring: Hungarian Migration of Modern Times, *in* International Migrations, Vol. 2, edited by W. F. Willcox (Publs. Natl. Bur. of Econ. Research, Inc., No. 18), New York, 1931, pp. 411–439; references on pp. 424, 429, and 434.

Budapest, the largest numbers were furnished by the following counties: Szatmár, 144; Heves, 134; Vas, 125; Szabolcs, 123; Veszprém, 121; Borsod, 97; Abaúj-Torna, 82; Zala, 73; Sopron, 52; Győr, 43; Békés, 38; Somogy, 37.

A comparison of the percentages contributed by these 12 counties to the *tanya* settlers, the migrants to Budapest, and the sample of

TABLE V—RELATIVE CONTRIBUTIONS OF HUNGARIAN COUNTIES TO TYPES OF MIGRATION

COUNTY (*See Fig. 3*)	POPULATION 1930	DETROIT*	PERCENTAGE BUDAPEST†	TANYA§
Szatmár (XXXI)	125.744	10.74	0.55	1.51
Heves (XVIII)	316.468	10.00	3.56	.....
Vas (IX)	274.913	9.38	4.65	.....
Szabolcs (XXX)	389.123	9.23	2.08	9.30
Veszprém (X)	243.437	9.08	5.37	.....
Borsod (XXIII)	440.278	7.23	2.29	.....
Abaúj-Torna (XXI)	91.413	6.11	0.36	.....
Zala (XI)	365.120	5.44	5.25	.....
Sopron (VII)	179.231	3.88	2.63	.....
Győr (III)	147.743	3.21	2.42	.....
Békés (XXVII)	330.242	2.83	2.78	12.01
Somogy (VI)	385.371	2.76	4.06	.....

*Sample of 1341 Hungarians. †359.403 migrants. §896.918 settlers.

Hungarian residents in Detroit is significant. Although these 12 counties furnished 79.89 per cent of the sample of immigrants from present Hungary outside Budapest resident in Detroit, they furnished only 36.00 per cent of the migrants to Budapest and only 22.82 per cent of the *tanya* settlers.

These counties are characterized by the predominance of agriculturists in the occupational distribution of their population. Of all employed persons in Hungary outside the autonomous cities, 66.2 per cent were engaged in agriculture.[24] The percentage of agriculturists for nearly every one of these 12 counties was higher than that for the entire country. In Szatmár County it was 79.6 per cent; in Szabolcs, 72.3; in Győr, 79.8; and in Abaúj-Torna, 74.0.

Investigation of the commune of origin of the same sample of Hungarian residents of Detroit furnished additional evidence of the rural character of these immigrants. Although 54.9 per cent of the population of Hungary live in communes of more than 5000 inhabitants, only 20.8 per cent of the Detroit group were born in such communes. The Hungarian immigrants who have settled in Detroit

[24] *Magyar Statisztikai Évkönyv*, No. 36 (N.S.), 1928, Budapest, 1930.

appear to have come not only from the more rural and agricultural regions of Hungary but also to a large extent from the smaller communes rather than from the larger communes or the cities.

A further indication of the cultural difference between the centers of migration to Budapest and to Detroit is shown by the birth rates of the counties. In 1930 the birth rate for all Hungary was 25.4 live births to 1000 inhabitants. Pest-Pilis-Solt-Kiskun County, which contributed 23.73 per cent of the migrants from present Hungary to Budapest and only 1.12 per cent of the Detroit group, had a birth rate of 23.6. The Dunántúl region, which has long furnished the bulk of the population of the capital, had a birth rate of 24.6. On the other hand, several of the counties that furnished the highest percentages of the Detroit group had birth rates considerably higher than that of the entire country. The birth rate of Szatmár was 35.8; that of Szabolcs 37.6; and that of Heves 28.8. In Hungary the diffusion of the practice of birth control among the peasantry and the consequent decline in the birth rate appear to be reliable indexes of the extent of contact with urban culture.

The cultural background of the migrants to Budapest thus is significantly different from that of the Hungarian immigrants who have settled in Detroit. Migration from rural Hungary to Budapest tends to show a close relationship to the spread of urban culture. Peasants and the daughters of peasants have gone to the metropolis to escape from the primary group associations and controls of peasant villages and to gain higher social and economic status in what was to them a new world. On the other hand, the immigrants who settled in Detroit came largely from those regions that have been least affected by urban culture. A large number of the Hungarian immigrants who were interviewed stated that at the time of migration they had had no desire to remain permanently in the United States. Their hope was that they might attain a more satisfactory economic and social status in their home village through the wages that they might earn during their sojourn in America. Dissatisfied as they were with their position in the village community, they still felt themselves very much a part of it. Unlike the peasants who migrated to Budapest, these immigrants to America had little intention at first of breaking away from the primary group relationships of peasant life. To some extent the foreign-language colony has helped to prolong the security afforded by peasant society and has lessened the personal disorganization resulting from the sudden change of social environment.

THE NICHOLS MO-SO MANUSCRIPT OF THE AMERICAN GEOGRAPHICAL SOCIETY

Joseph F. Rock

IN the April, 1916, number of the *Geographical Review* the late Dr. Berthold Laufer gave a brief description of the Mo-so manuscript from northwestern Yunnan presented to the American Geographical Society by Francis H. Nichols.[1]

Before publication of Dr. Laufer's paper several would-be translations of Mo-so manuscripts had appeared. That published by Prince Henri d'Orléans has nothing in common with the original text.[2] Another supposed translation was published by Bonin in 1898.[3] Although, unfortunately, Bonin does not give the original Mo-so text, it is certain that his translation is incorrect.[4] Terrien de Lacouperie gives several plates showing Mo-so script.[5] They represent pages of two manuscripts, one of which was procured by Captain W. Gill and the other by Father A. Desgodins. These texts have been neither translated nor commented on. Gill's manuscript I recognize as the story of an ancestor of the Mo-so, or Nakhi, race, from a book entitled "Gkaw-lä-tsü aw sher."[6] The Desgodins manuscript relates the origin of the *ch'ou* demons, or demons of impurity. Bacot gives several plates of reproductions of original Mo-so manuscripts with translations.[7] Figures 30, 31, 32, and 33 (Plates 18 and 19) represent part of the text of a manuscript entitled "Dto-mba Shi-lo t'u bbue (The Origin of the Dto-

[1] Berthold Laufer: The Nichols Mo-So Manuscript, *Geogr. Rev.*, Vol. 1, 1916, pp. 274–285.

[2] Prince Henri d'Orléans, in his book "From Tonkin to India" (translated by Hamley Bent, London, 1898), pages 452–455, gives a few pages of text and translations of what purports to be an account of the creation of the world and so on. In fact, the book is entitled "K'o ngv tsu t'u bbue, dsä t'u bbue, dtĕr t'u bbue (The Origin of the Nine K'o Demons, the Dsä Demons [with split heads], and the Dtĕr [headless] Demons)." This book belongs to a ceremony called *k'o ngv tsu t'u*, the driving out (*t'u*) of the *Ko ngv tsu*, or nine (*ngv*) k'o demons (*tsu*). The word *k'o*, the name of the demons, is written with the character for "basket," which has the same phonetic value (*k'o*), and the character for "nine" is written over it.

[3] C.-E. Bonin: Note sur un manuscript mosso, *Actes du Onzième Congr. Internatl. des Orientalistes, Paris, 1897*, Sect. 2, Paris, 1898, pp. 1–10; and also his book "Les royaumes des neiges (états himalayens)," Paris, 1911, pp. 281–296.

[4] Many manuscripts begin thus: "The Tibetans are best able to cast horoscopes for the year, the Min-chia [a tribe, the original inhabitants of the Nan-chao Kingdom] for the month, and the Mo-so [or Nakhi] for the day." Bonin renders this: "Le Tibétain (Koutsong) sous le signe favorable du Chevreuil (porte-musc) [*ffu* pronounced in the third tone means "rat"; the same character, a picture of the rat, is also read *kv* (third tone), meaning "year." As the rat is the leader of the twelve animal cycles for the year, the character representing the rat also stands for "year," "year" being an abstract term that cannot be expressed with pictographs]. Du feu (sort) le Min-kia (au) mois favorable. Le Mosso repose (dans la nuit) favorable."

[5] Beginnings of Writing in Central and Eastern Asia, London, 1894.

[6] Gkaw-lä-tsü calling the soul of his father; Gkaw-lä-tsü was the son of O-gkaw-lä one of the ancestors of the Nakhi race; the latter had been devoured by a bear while sleeping under a pine tree, tired from the hunt. It is the key book of the great funeral ceremony called Khi nv. The *ɣiruatsa* referred to by Laufer (*op. cit.*, p. 284) as appearing in the title page of this manuscript is called *ler mbu chi* in Nakhi (Tibetan *ḍpal-gyi-beḥu*). The *dto-mbas* look upon it as representing the heart of the gods.

[7] J. Bacot: Les Mo-so: Ethnographie des Mo-so, leurs religions, leur langue et leur écriture, Leiden, 1913.

mba Shi-lo)." Shi-lo was founder of the Nakhi shamanism, the ancient pre-Buddhistic religion of Tibet. Bacot gives a fairly good translation of part of the text.[8] The book is chanted with more than a hundred others at the *Shi-lo nv* ceremony, a funeral ceremony for a *dto-mba*, or Nakhi sorcerer.

The present writer hopes to publish in the near future a Nakhi work of a very different type, a tragic and beautiful romance called "Lv mber lv zaw ssaw," the love story of the first Nakhi girl, K'a mä-gyu-mi-gki, who committed suicide by hanging herself to the *nda* tree. One would hardly expect to find such language among a primitive and virile tribe like the Nakhi. Truly the poem may be looked upon as one of their great epics.

The Dto-mba Ceremonies and Books

Mr. Nichols wrote from Burma on September 20, 1904: "My greatest treasure I enclose. It is a book in the Ton-ke,[9] the original language of the Mo-so tribe, who now speak and write Tibetan. Books like this one are exceedingly rare and difficult to obtain."

Nakhi, or Mo-so, manuscripts are not so rare now as they were once thought to be, but complete sets of books are very rare. The dto-mba, or sorcerer, business is more or less on the wane, and the dto-mbas today are not so particular about the number of books they chant at a ceremony. The main objects nowadays are the slaughter of pigs, sheep, goats, and chickens and the feasting on them; the sooner the chanting is finished, the more time remains for eating. There are more than a hundred different kinds of ceremony, to each of which a certain number of books pertain. At some of the larger ceremonies, which sometimes last from five to seven days, as many as 150 different books have been chanted in a recognized sequence. Every one of the ceremonies has its special books that can be chanted only at that particular ceremony. Other books are common to all ceremonies, the texts differing only slightly: there are not very many of these, however. I have been able during more than ten years' contact with the Nakhi to collect complete sets of manuscripts, all arranged according to the ceremony. Most of these ceremonies I have had performed for me, sometimes by as many as twelve dto-mbas. The greater part of this mass of literature I have been able to translate, and, while doing so, with the constant assistance of two dto-mbas, I have compiled a fairly complete dictionary of the written language of the Nakhi, comprising both the pictographic and the syllabic types.

The word *dto-mba* (Chinese *to-pa*) is of Tibetan origin and is the

[8] *Ibid.*, pp. 18–20.

[9] It is possible that "Ton-ke" means "the dto-mba language" as Dr. Laufer supposes; for many of the Mo-so, or Nakhi, who live on the Mekong or near Wei-hsi speak Tibetan, and their language is a mixture of Nakhi and Tibetan: yet it is likelier that the dto-mba who gave Nichols the manuscript meant to say that it belonged to the *to-k'ö* or *dto-k'ö* ceremony, which is actually the case.

equivalent of the Tibetan *ston-pa* (pronounced *ton-pa*), meaning "teacher," or "founder," or "promulgator of a particular doctrine." The Nakhi pronounce the first letter in *dto-mba* neither hard like *t* nor soft like *d;* hence I have transcribed it with *dt*.

According to the Nakhi (black people), the dto-mba Shi-lo had several incarnations. One of these was passed in the district of Bĕr-dĕr in the Chung-tien magistracy within the Yangtze loop, in a limestone cave called to this day Shi-lo Ne-k'o, or Shi-lo's Cave, the mecca of every dto-mba. In the Li-chiang district proper the dto-mbas are losing ground, and their services are now required only by older women. At La-pao, a district three stages north of Li-chiang, however, they are still very much in demand.

Dr. Laufer speaks of Bonin's Mo-so manuscript as illuminated, or rather he states that pigments had been applied to the characters. I have in my possession some very beautifully illuminated manuscripts, in some of which the deities mentioned are beautifully painted. The books were written with a bamboo stylus. The paper is made from plants that grow wild in the mountains in the district of Li-chiang, from the stringy stems of several species of the genera *Daphne* and *Wikstroemia* (the latter is called *wan dter* by the Nakhi). Dr. Laufer states that Dr. Millspaugh had determined the paper of the Nichols Mo-so manuscript to have been made from the fiber of the bark of *Streblus asper*. This is a tropical plant, however, and does not grow in northwestern Yunnan.

The Nichols Manuscript

The Nichols Mo-so manuscript, of which Dr. Laufer published four pages, represents a book used in three different ceremonies, the *dto-na k'ö*, the *hăr-la-llü k'ö*, and the *tsu t'u* ceremonies. All these ceremonies are performed for the purpose of exorcising demons who have either brought illness to a household or caused other misfortunes. During the ceremonies the demons are driven out with the help of certain deities. Three types of spirit are especially besought to help the dto-mbas in banishing the evil spirits; viz. *dtĕr-gko*, *bö-mbö*, and *bä-da*. There follow a detailed description and explanation of the four pages of the Nichols Mo-so manuscript published by Dr. Laufer and reproduced herewith (Figs. 1–4).

The First Folio, Recto (Title Page)

In Figures 1 and 2 are shown the title page and its reverse side. The first line of the title page, divided into three rubrics, contains the title of the book, the second line a prayer for the granting of a wish.

The title runs: (rubric 1) Dtĕr-gko ssaw, (rubric 2) Bö-mbö ssaw, (rubric 3) Bä-da ssaw Bä-da t'u bbue. This may be translated: "Inviting the Dtĕr-gko, Inviting the Bö-mbö, Inviting the Bä-da, and the Origin of the Bä-da."

FIG. 1

FIG. 2

The Mexican manuscript of the American Museum of Natural History (Codex Fejérváry-Mayer)

FIG. 3

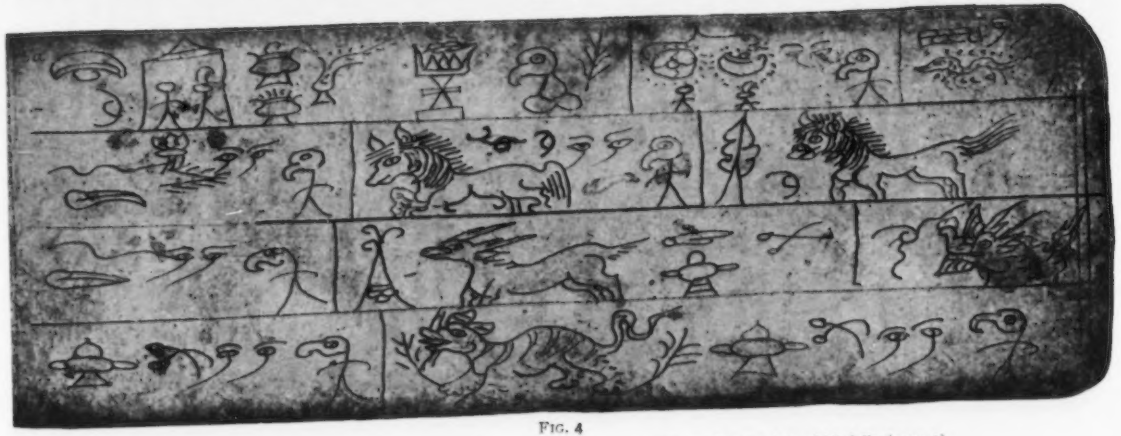

FIG. 4

FIG. 3—Recto of the second folio (page 3).

FIG. 4—Recto of the fifth folio (page 9).

The *dtĕr-gko*, of whom there are 360, are protective tutelary spirits, equivalent to the 360 *thugs-dkar* of the Bon. They are winged and may be considered Yidam or their equivalent. As they can suppress demons, whenever a ceremony is performed during which demons are to be exorcised these dtĕr-gko are besought to drive them out; *ssaw* means "to invite." The *bö-mbö* of the second rubric are dto-mbas of the dim past or dto-mbas of the gods; here also are meant the five regional bö-mbö, or *khyü-zhĕr bö-mbö*, the five maternal uncles of dto-mba Shi-lo. They too are invited to the ceremony to help drive out the demons.

The *bä-da* of the third rubric, of whom there are 39 divided into three groups of 13 each, are the spirit warriors of the gods. They are said to dwell on Muan-mi-bo-lo (ngyu) (Mt. Muan-mi-bo-lo). This mountain is identical with the Tibetan rMa-chen spom-ra or Amnyi Machen, the Chinese Chi-shih shan, which rises west of the Yellow River and northeast of its source. The mountain is also called Ma-mi-bo-lo in Nakhi; for the Nakhi say that around it are many butter (*ma* = butter) lamps (*mi* = fire) that have been placed there by pilgrims. Thousands of pilgrims circumambulate the mountain, especially during the Year of the Horse.

The Nichols manuscript is an abridgment, presenting the substance of what is usually written in three different books under the three titles that appear on the title page of the manuscript.

The second line of the title page reads: T'ä-ghügh, sz shĕr haw yi ho. Freely translated, this means "May long life be granted this book." The two words *t'ä*,[10] "learned," and *ghügh*, "good," are employed for "book"; *sz shĕr haw yi ho* means "long-life generations day have may," or "may long life be granted."

The First Folio, Verso

In Figure 2, showing the verso of the first folio, the following are represented from left to right: (1) A tiger (*la*),[11] called in the Nakhi books *Boa dü la hō* ("Boa land tiger red" or "the red tiger of Boa or the land of the Hsi-fan"). (2, the central picture) Garuda, a mythical bird, called in Nakhi *dtu-p'är khyu-t'khyu* (the Nakhi are

[10] The words t'ä-ghügh "book" belong to the first line of the title page and always follow the actual name of the book; the second line contains only the pious wish of the Dto-mba who wrote the book. *T'ä* in the second tone means "flag"; "learned" in Nakhi is also *t'ä* and has the same tone value as "flag"; hence the character for "flag" used in writing the first syllable for "book." The second character, a piece of paper in the shape of a Nakhi book with a stylus above it indicating "writing," really should be read *mbue bĕr*, "to write." Its phonetic value, however, is here ignored and the ideographic alone suggested and with the word *t'ä* is read *ghügh* (or *rür*; the *r*, however, is a more guttural one usually transcribed by *gh*).

[11] Laufer, *op. cit.*, p. 281, refers to the tiger, called *taç* (*stag*) in Tibetan, as playing the role of a powerful deity in the shamanism of Tibet. The tiger, called *la* in Nakhi, is always spoken of in the dto-mba books as *Boa dü la hō;* on Nakhi paintings the tiger always appears in company with the yak as one of the guardians to the gates of the realm of the gods. The mythical Tibetan lion, called *shi* in Nakhi, appears very often in the dto-mba books, but it is mentioned there as *dtu-p'är ssi-nge*, "the *ssi-nge* (lion) with the white belly"; *dtu-p'är* means "conch shell," and the reference is to the fact that the lion's belly is as white as a conch shell. The yak, Garuda, and lion form a kind of trinity and are collectively called *ngaw-la mber t'khyu ssi sso*, meaning "the victorious (aiding) yak, Garuda, lion (*ssi*), three" (*sso* is the Tibetan for "three," the Nakhi term being *ssu*). As in Hindu mythology, in the dto-mba books the Garuda or *khyu-t'khyu* has a companion, for it appears as the riding beast of the central one of the five regional bö-mbö, the dto-mba Sso-yu-dzi-gv. The Garuda's wife, called *khyu gu* in Nakhi, serves as the riding beast of the bat, Ha-yi-dzi-boa, which went to heaven to secure the 360 *p'a-dso* or horoscope books from a goddess called P'är-ndzi-ssaw-mä: this legend is in a book called "Bpö p'a gko shu." Among the many books belonging to the *ssu gv* ceremony, in which all the serpent spirits (*llü-mun* (Nagas in Hindu mythology); Tibetan *klu*) are propitiated, there is one entitled "Khyu-t'khyu ssu a," meaning "The Fight between the Garuda and the Serpent Kings." In the dto-mba books the serpent kings are called either *ssu* or *llü-mun*, *a* means "fight."

In the "Khyu-t'khyu ssu a" the Garuda is depicted as holding the terrestrial serpent king Tso-na lo chi by the hair (he is half man and half snake) and winding his snakelike body around the mystic mountain Ngu-na Shi-lo (Mt. Su-meru). More than 100 books belong to the *ssu gv* ceremony, all of which I have translated.

unable to pronounce a final *n* or *ng;* otherwise this name would be identical with the Tibetan name for the same bird, *khyung*). (3) Two characters, which are read *Ssa dto*, the first standing for the first part of Ssa-tkhi, the name of a famous dto-mba, and the second for *dto-mba*. (4) The figure of Ssa-tkhi treading on a demon and holding in his right hand a hand drum or *damaru*, called in Nakhi *ndaw-k'o*, and in his left a cymbal with a tongue, an instrument peculiar to the Nakhi, who call it *tz-lĕr*. The figure is not that of Padmasambhava,[12] nor does the manuscript represent a chapter or a story from his life, as Dr. Laufer felt assured.[13] In fact, neither this saint nor Avalokiteshvara is ever mentioned in any of the Nakhi books known to me. The figure wears the five-lobed crown called *k'o* in Nakhi that is worn by all officiating dto-mbas. In Tibetan such a crown is called *rigs-lnga* (pronounced *rig-na*), and, as on the *k'o* of the dto-mbas, each segment bears the picture of a deity.

The Second Folio, Recto (Figure 3)

The page of the Nichols Mo-so manuscript represented in Figure 3 is divided into four lines. Each line except the first is divided into rubrics, the second consisting of two rubrics, the third of three, and the fourth of four. These I shall number consecutively from one to ten. It may be remarked here that the dto-mba custom is actually to write only a very few words or characters. These serve more or less as prompters to the memory, and much more that is not written has to be read into the text. Furthermore, a single character appearing in a phrase may do duty three or four times; i.e. it is read that number of times. Consequently, unless one is familiar with the story—has learned it by heart, indeed—it is impossible to read it no matter how accomplished a Nakhi scholar one may be. Only in books containing magic formulas or *dhâraṇi* is every character written. I cannot enter here into a lengthy discussion about the peculiarities of the Nakhi scripts, which I reserve for a forthcoming monograph on that interesting tribe. In the following transcription words that are written are given in italics. Even though they appear written only once, many of them are read three or four times.

Transcription:[14] (1) ²*Bi* ²t'u ²*muan* ²chi ₁*hu*, ²*yi* ₁*nda* ²*chi* ²*ddū* ₁*gyi*, *P'ă̆r* ²gkaw ₁*ndsher* ²gkaw ²*tkhi*, ²*ngaw* ²gkaw ₁*wu* ²gkaw ²*tkhi*, *O*² ²gkaw ₁*hä* ²gkaw ²*tkhi*. (2) ²*Dtĕr* ₁*gko*, ²*Yu* ₁*ma* ₁*ssu* ²*khi chwua*³ ₁*tsĕr* ²lä ²gkaw ²*tkhi*. (3) ²*Chi* ₁*hu Llū*³ *gkv*³ ²*bö* ₁*mbö* ²nnü, ₁*dtĕr* ₁*tsu* ₁bö ²lä *t'u*³. (4) ²*Dtĕr* ₁*gko* ²*ssi* ²yu ²*muan* ²*ssi* ₁ssü ²*muan* ₁dgyu. (5) ₁*Dto* ²yu ²*muan* ₁*dto* ₁ssü ²*muan* ₁dgyu. (6) ²*Mi* ²yu ²*muan* ²*mi* ₁ssü ²*muan* ₁dgyu. (7) ₁*Ndsher* ²yu ²*muan* ²yi ₁ssü ²*muan* ₁dgyu ²ggŏ ₁*ndshĕr*. (8) ²*Dtĕr* ₁*gko* ₁*yu* ²yu ₁zä ²nnü ₁yu ²*muan* ₁dto. (9) ²Dtĕr ₁gko ²*t'u* ²gkv *bbue*³ ²gkv ²*muan sho*³ ²mä, ₁*yu* ggŏ ²*t'u* ²lä *bbue*³ ₁dso *sho*³ ²*muan* ²nyi. (10) ²*Dtĕr* ₁*gko* dgyü³ ₁*ch'ung* . . .

Literal translation: (1) Sun rise no this night, landlord this one family, *p'ă̆r* power *ndsher* power invite, *ngaw* power *wu* power invite, *O* power *hä* power invite. (2) *Dtĕr-gko*, *yu-ma* three hundred six ten (sixty) again power invite. (3) This evening *Llū gkv bö-mbö* he *dtĕr* demon outside again drive. (4) *Dtĕr-gko* knowing not knowing things not exist. (5) Seen not seen things not exist. (6) Heard not heard things not exist. (7) Power not got things not exist their power. (8) *Dtĕr-gko* born but where they born not seen. (9) *Dtĕr-gko* come forth place, arise place not told if born their come forth again origin about speak not can. (10) The *dtĕr-gko* in the beginning . . .

Free translation: (1) Tonight the family invites the power of the *p'ă̆r*, the *ndsher*, the *ngaw*, and the *wu*, and also the *o* and *hä* [all the gods]. (2) The power of the 360

[12] Bacot, *op. cit.*, Plate 16, shows dto-mba Shi-lo, not Padmasambhava.

[13] Laufer, *op. cit.*, p. 283.

[14] In this and the subsequent transcriptions ₁= first tone, ²= second tone, and ³= third tone. The Nakhi have really four tones in their language, but the fourth is very rare, occurring mostly in loan words.

dtĕr-gko and *yu-ma* is again invited. (3) This evening the *llü gkv bö-mbö* again drives out the *dtĕr* demons. (4) There is nothing that the *dtĕr-gko* do not know [they are omniscient]. (5) There is nothing that is not seen by them. (6) Nor is there anything that has not been heard by them. (7) There is no power that they do not possess, such is their power. (8) Where the *dtĕr-gko* are born is known to no one. (9) And yet unless their origin is known one must never speak about them. (10) In the beginning of time the *dtĕr-gko* . . .

Notes: 1. The first character represents the sun, the second the moon, and the character between and below the sun and the moon stands for "not" (it represents an empty animal trap, hence "not," "nothing," "no"). The words for "sun" are *nyi-mä* in the colloquial, *nyi* in the written language, and *bi*, an ancient term. The phrase really means "on the day the sun had risen but is no more," hence "tonight."

The next character represents a man and his wife, the latter recognizable by the knot of hair covered with a cloth, even today the headdress of the women. The *p'ar* and *ndsher* are house spirits, the *ngaw* are spirits of aid and succor, and the *wu* are their attendants. There are sixteen *ngaw*, who are said to protect that which has two legs and also that which has four legs. The character for *ngaw* is a flag, since an army is led to victory with a flag; *ngaw* also means "aid," "succor," "victory." The character for *wu*, a bowl filled with food, stands for the word "slave" or "attendant"; it is here used only as a phonetic. *O* and *hä* represent male and female gods or spirits.

2. The *dtĕr-gko* have been explained above. They are represented by a hawk-headed winged figure. A number of them are described and their names given in the book entitled "Dtĕr-gko ssaw." The *yu-ma*, also called *wua-ma* in some dto-mba books, are also protective deities, or rather demigods, and number 360; they follow the 360 dtĕr-gko and are identical with the 360 *wer-ma* of the Bon, who follow the 360 *thugs-dkar* of the Bon. The yu-ma[15] are winged creatures; most of them have lion heads, but some have heads of other animals. They are described in a book called "Yu-ma ssaw." The three swastikas here stand for 300 (more usually written +++), and the six dots stand for 60. The last character in the rubric, which is read *t'khi* and represents a spine, serves here only as a phonetic.[16]

3. The third character represents a dto-mba driving out demons pictured in a suppressed position. *Llü gkv bö-mbö* may be explained as follows: *Llü* is part of the name of the great ancestor of the Nakhi, Ts'o-dze-llü-ghügh, and a dto-mba is here meant who follows in the footsteps of the dto-mba of that ancestor; *gkv* means "able," *bö* "chant," and *mbö* "divide" or "separate"; hence a dto-mba who is able by chanting to separate the demons from the people. The dtĕr demons are headless; one is depicted next to the regular character for demon. All persons who die violent deaths, such as falling from cliffs, being devoured by leopards, being shot, etc., turn into headless demons or *dtĕr tsu* (dtĕr demons). It is also believed that the dtĕr demons cause such violent deaths.

4. The third character represents a tree and also wood; it is here read *ssi*, being employed as a phonetic and doing duty for *ssi*, "to know."

5. The second character represents a pair of eyes with lines protruding, hence *dto*, "to see"; the fourth character stands for a dtĕr-gko.

6. The first character represents a person with exaggerated ears and lines entering them, hence "to hear"; this character, however, is not read but is employed to explain the last character, *mi*, "fire," a picture of three flames or fire, used as a phonetic for *mi*, "to hear." Without the first figure the last would be unintelligible;

[15] The figure in Plate 14 in Bacot's "Les Mo-so," which he calls "Peinture pömbo = Garuda," is not the Garuda but the lion-headed *t'u chi yu-ma* of Nakhi. The Garuda is on the top center. Surrounding the large central figure of the t'u chi yu-ma are other yu-ma with the heads of various animals.

[16] "To invite" or "engage" is called *t'khi* in Nakhi and has the same phonetic value as *t'khi*, "spine," written with the picture of a spine. *Gkaw t'khi* means to invite the strength or power (of the gods), the latter being rendered by *p'u la*. There are separate books called "P'u la gkaw t'khi."

7. The third and last characters are read *ndsher*, "power" (protective power). this is a *ggo-ba* or syllabic character, also read *ssa* (only, however, when used in names).

8. The first character represents a dtĕr-gko. The second is the head of a *yü* or monkey; it is here used as a phonetic for *yü*, "to be born."

9. The character under the monkey's head represents a wooden trough and is read *t'u* in the first tone; read in the second tone it means "to come forth" and thus explains the word *yü*. The character *shou* is a syllabic one and means "to tell." The character *bbue* under the last monkey's head is the picture of an *Artemisia* branch or *bbue* read in the second tone; here, however, where it is read in the third tone, it means "origin."

The Fifth Folio, Recto (Figure 4)

Transcription: (1) ²Bi ²t'u ²*muan* ²chi ₁*hu*, ²*yi* ₁*nda* ²*chi* ²*ddü* ₁*gyi*, ²mbĕr ₁yu ²*zhi* ²*haw* ²nnü ₁cher na³ *khyu*³ ₁ma ²nnü, ²*dtĕr* ₁*gko tsu*³ ²*bpa* ₁ggŏ ²lä ₁bä. (2) ²*Dtĕr* ₁*gko* ²*muan* ²ggŏ ²*nyi* ²*mä* ²*hä* ²*mä* ²*zo mi*³ ²ssu ₁yu ₁ngyu nun³ ²muan ₁ngyu ²mä, ²khi ²nnü ²muan ₁*dto* ²*dtĕr* ₁*gko* ²mä ²nnü ₁*dto*. (3) ²*Llü* ₁bbu *t'khyo*³ ²*lo* ²zo mi³ ²ssu ₁yu ₁ngyu nun³ ²muan ²ngyu ²mä, ²khi ²nnü ²muan ₁*dto* ²*dtĕr-* ₁*gko* ²mä ²nnü ₁*dto*. (4) ₁Mbu ²*man* ₁*bbĕr* ²lä ₁*gyi* ₁nyu *gku*³, ²gkv *man*³ ²dto ²bä ²muan ²dto ²bä, ²wan ₁dgyu dta³ nun³ ₁yi ₁dgyu dta³, ²khi ²nnü ²muan ₁*dto* ²*dtĕr* ₁*gko* ²mä ²nnü ₁*dto*. (5) ²*Muan* ²ggŏ ₁*na dta*³ ₁*dgyu* ²*lu* ₁*mbu* ²*man* ²ssu ₁yu ₁dzu nun³ ²*muan* ₁dzu ²mä, ²khi ²nnü ²*muan* ₁*dto*, ²*dtĕr* ₁*gko* ²mä ²nnü ₁*dto*. (6) ₁Dü ²ggŏ ²*khyü dta*³ ₁*dgyu* ²*lu* ₁*mbu* ²*man* ²ssu ₁yu ₁dzu nun³ ²*muan* ₁dzu ²mä, ₁*mbu* ²*man* . . . (7) ₁*bbĕr* ²lä ₁*gyi* ₁nyu gku³, ²gkv man³ ²dto ²bä ²muan ²dto ²bä, ²wan- ₁dgyu dta³ nun³ ₁yi ₁dgyu dta³, ²khi ²nnü ²muan ₁*dto* ²*dtĕr* ₁*gko* ²mä ²nnü ₁*dto*. (8) ²*Nv* ²*lv* ₁*ndü* t'khi³ ²ghügh ₁zhi ²ghügh *chwua*³ ₁p'är, ₁*shi* ²mbbu ₁*ddü gkyi*³ ²yi nun³ ²muan ²yi ²mä, ²khi ²nnü ²muan ₁dto ²dtĕr ₁gko ²mä ²nnü ₁dto. (9) ²*Muan* ²ggŏ ²*o* ₁*har* ²*muan* ²*ndshĕr*, ²*k'o* ²yu ²wan p'u³ . . . (10) ₁ddü nun³ ₁yi p'u³ *gkyi*³, ²khi ²nnü ²muan ₁*dto* ²*dtĕr* ₁*gko* ²mä ²nnü ₁*dto*. (11) *Llü*³ ₁*ch'ung llü*³ ₁*na k'o*³, ²Boa ₁dü ²*la* ₁hö, *bbĕr*³ ₁*ddü* ₁dzu nun³ *bbĕr*³ *gkyi*³ ₁dzu, ²khi ²nnü ²muan ₁*dto*, ²*dtĕr* ₁*gko* ²mä ²nnü ₁*dto*.

Literal translation: (1) Sun rises not this night, landlord this one family, yak, sheep, wine, food, these fat lean (meat), juniper, butter these the *dtĕr-gko tsu bpa* on high again do. (2) *Dtĕr-gko* heaven of (celestial) sun moon son daughter many is or not is man he not seen, *dtĕr-gko* but they seen. (3) Earth below ant sons daughters many is or not is man he not seen, *dtĕr-gko* but they seen. (4) [This rubric need not be translated, since it is repeated in the second half of rubric 6. It does not belong here. Being on the point of leaving out two entire rubrics, the writer discovered his error, followed with the proper sentences, and repeated rubric 4 in its proper place.] (5) Celestrial (heaven of) *na dta dgyu lu* mane tail many born or not born indeed, man he not seen, *dtĕr-gko* but they seen. (6) Terrestrial (earth of) *khyü dta dgyu lu* mane tail many born or not born indeed, mane tail (7) pluck again water into throw, head tail upside not upside down, left side attached, or right side attached man he not see, *dtĕr-gko* indeed they seen. (8) *Nv lv ndü t'khi ghügh zhi ghügh chwua p'ār* (the white elk) flesh fat large small is or not is indeed, man he not see, *dtĕr-gko* they indeed seen. (9) Celestial green dragon horns if left (10) large or right small, man he not see, *dtĕr-gko* but they seen. (11) *Llü ch'ung llü na k'o* Hsi-fan land tiger red, stripes large born or stripes small born, man he not see, *dtĕr-gko* but they seen.

Free translation: (1) Tonight the family offers again to the dtĕr-gko on high a *tsu bpa* consisting of yak meat, mutton, wine, food [any kind of grain, such as rice, barley, or wheat, etc., boiled with meat or vegetables is called *haw*, "food"], bacon or lean pork, juniper twigs, and butter. (2) How many sons and daughters the celestial dtĕr-gko of the sun and moon have, man has not seen, but the dtĕr-gko have. (3) How many sons and daughters the ants have under the soil, man does not know, but the dtĕr-gko do. (5) How many hairs the celestial *na dta dgyu lu* has in its mane and

tail man does not know, yet the dtĕr-gko do. (6) How many hairs the terrestrial *khyü dta dgyu lu* has in its mane and tail or if the hairs of the mane and tail are plucked out and thrown into the water, whether they [float down] head up or tail down or become attached on either the left or the right side of the bank, man does not know but the dtĕr-gko indeed know. [The word *bber*, "pluck," belongs to the seventh rubric.] (8) Whether the flesh of the white elk that roams on the *nv lv ndü t'khi ghügh* (the snow range where the fog settles) is fat or lean man has not seen, yet the dtĕr-gko have. (9) Whether of the horns of the dragon the left one is large and the right one is small man has not seen, yet the dtĕr-gko have. [The word "large" belongs to the tenth rubric.] (11) Whether the stripes of the red tiger of the land of the Hsi-fan that dwells in *llü ch'ung llü na k'o* are large or small man has not seen, yet the dtĕr-gko have.

Notes: 1. In "Sun rises not this night" only *hu*, "moon" (read "night"), and *muan*, "not," are written; *muan* belongs to the unwritten "sun rises not." The two bowls represent food, *haw*, but only the first, or upper one, is read. The third character after the house representing the family is a jar of strong liquor evaporating, and the fourth, read *tsu bpa*, is a basin holding a fire of juniper twigs on which the various food offerings mentioned are burned (in only small bits) and is equivalent to the Tibetan Çug-pa.

2. The first character represents the vault of heaven with the sun and moon; below the sun is a boy and below the moon a girl; the dots represent a large quantity.

3. The first upper character is earth in the sense of soil; below it is an ant.

5. The horse with the Tibetan—and also Nakhi—character for *na*, "black," above it is here read *na dta dgyu lu;* the word *dta* is a loan word from the Tibetan *rta*, "horse." This horse, the equivalent of the Tibetan *rta-rna-ri*, is believed to dwell in one of the seven golden mountains called Ha-ngyu sher-ngyu over which the souls of the dead have to travel on their way to the realms of the gods. The words for "mane" (*mbü*) and "tail" (*man*) are not exactly written but are especially emphasized in the drawing of the horse.

6. The first character, read *khyü*, "juniper," stands as a phonetic and as part of the name; the horse is the terrestrial counterpart of the *na dta dgyu lu*. I have been unable to find any other reference to this horse in other dto-mba books.

7. The first upper character is a picture of a rope: read *bbĕr* in the first tone it means "rope"; here, however, it is used as a phonetic for "to pluck" (*bbĕr*, also read in the first tone). The character below it is read *gyi*, "water."

8. The first character represents a mountain. Inside the mountain is the character for *nv*, "silver"; hence a snow mountain is meant. The character on the top of the mountain is read *ndü*, "to sink," "to settle," and is part of the name; originally *ndi* or *ndyi*, it represents the young shoots of the bracken fern *Pteridium aquilinum*. *T'khi*, "fog," is not written; a part of a snow mountain where the fogs settle is meant and it is there that the elks roam. The elk is self-explanatory, but the term *zhi ghügh*, "dead cow" or "ox," must be explained. This term signifies "ox of the dead," since the elk is always mentioned as the ox used by the dead in plowing their fields in the other world. *Chwua* means "elk" and *p'ār* "white." The next character represents a piece of meat; the character under it, read *ddü*, "large," is a phonetic; it originally represented a *mani* or rosary, called *bbue ddü* in Nakhi. The next character, read *gkyi*, "small," represents a pair of shears used in the shearing of sheep only; it is also called *gkyi:* both words are pronounced in the third tone.

9. This character represents a dragon called *o har muan ndsher*, literally "green heaven power," "the power of the green (or blue) heaven." (The turquoise is also called *o-har*, which may be translated either "green" or "blue.")

10. These characters are explained in connection with rubric 8.

11. The tiger lying down between the two trees is read *llü ch'ung llü na k'o, Boa dü la hö. Llü ch'ung llü na* means fir trees growing all in a straight line down a moun-

tain slope that terminates in a meadow or grassy pocket called *k'o*. *Llü na* are black firs; *ch'ung* means "in a row." "Stripes," *bbĕr*, although not written, are indicated on the tiger.

GGO-BA SCRIPT

Dr. Laufer furnishes illustrations of what he terms "abstract symbols of geometric character." This they truly are in a sense, but they belong to the syllabic script called *ggo-ba*, said to have been invented by the *dti-tz ggo ba*, or 360 disciples of dto-mba Shi-lo; hence the name *ggo-ba*. The first character shown in the last paragraph on page 284 of Laufer's paper is read *ngu*,[17] "horse." This is an ancient term for "horse," which is usually called *zhwua;* in the texts it is often called *dta* this being the Tibetan word.[18] The second character is also a syllabic one and is read *la*. It does not mean "road," however, but may stand for "tiger" or "hand." The third character shown does not exist in Nakhi.

[17] *Ngu* represents a large box in which the Nakhi store their grain; it is here used as a phonetic.

[18] *Dta*[2] in the ancient Nakhi language means "to speak," and the character represents an open mouth. In colloquial speech the mouth, including the lips, is called *nũn* [2]*dta*, *dta* being pronounced in the second tone.

THE CENTROGRAPHICAL METHOD AND REGIONAL ANALYSIS

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THE development of a fully adequate theory of regional analysis by statistical means is one of the outstanding problems of geography today. The map alone is not enough, nor are statistical data alone. They must be brought together. This is the aim of centrography.

To one who for the past fifteen years has devoted his chief attention to the methods of centrographical analysis the increasing interest in this field on the part of students of population is gratifying. Although computations and discussions concerned with centers of population and related points originated more than sixty years ago in the United States, during the past two decades many important developments in this and closely related fields have occurred in a dozen countries in Europe, Asia, and America. Increasingly frequent publication of articles in a variety of geographical and statistical journals in several languages has served to develop new methods, to correct various errors and misconceptions, and to clarify the interpretation of computed results.

The terms "centrography" and "centrogram," only recently suggested by the Mendeleev Centrographical Laboratory, relate to statistical analyses concerned with centers of population, median centers, median points, and related methods. Although such analyses originally were limited to studies dealing with human populations, they have been extended in more recent years to cover populations of farm animals, agricultural crops, manufactured goods, natural resources, and a variety of regional distributions of other social and economic factors. The term "centrography" expresses compactly the group of geographical studies in this field of two-dimensional statistical analysis and is worthy of the international acceptance that it seems rapidly to be winning, as may be gathered from the historical résumé given in the appendix.

The Mean Center

The well known "center of population" is a mean center, a center of gravity, or a center of mean distances. To explain all the details of this concept, its interpretation in various situations, and the practical

methods by which it may be computed would require more space than is available.[1] For practical computation of these centers it is necessary to divide a region into sections small enough to constitute a basis for a relatively precise evaluation of the features involved. For example, the communes are the smallest territorial units for which

FIG. 1—Centrogram of the Ukrainian Soviet Socialist Republic (1926). Key: centers of 1, area; 2 total population; 3, rural population; 4, urban population; 5, winter corn; 6, winter wheat; 7, summer wheat; 8, barley; 9, oats; 10, buckwheat; 11, millet; 12, maize; 13, horses; 14, cows; 15, oxen; 16, swine; 17, sheep; 18, goats; 19–21, sugar industry (persons engaged, production refined sugar, production molasses).

requisite population data are available in France; the square degree is the unit ordinarily used by the United States Bureau of the Census. A summary of localized data can then be obtained with sufficient exactness by considering the population as concentrated at the center of the unit area, usually defined by means of its latitude and longitude.

Many centrographers in different countries agree that the mean center is the best one both for summarizing most compactly and significantly distributions in a given region at a particular time and for showing general trends over a series of years. Several examples showing the position and movement of this center in various countries will be given.

[1] For fuller consideration of these points the reader is referred to the discussions in the reports of the U. S. Bureau of the Census or to the works of Mendeleev, Gini and Galvani, or Sviatlovsky cited in the appendix.

Figure 1 shows a considerable number of population, agricultural, and industrial centers in the Ukrainian Soviet Socialist Republic as computed for the year 1926 by the Centrographical Laboratory. Although most of these centers show a tendency to concentrate near the center of area and the center of general population, the extreme eastern position of the centers of oxen, goats, and summer wheat is

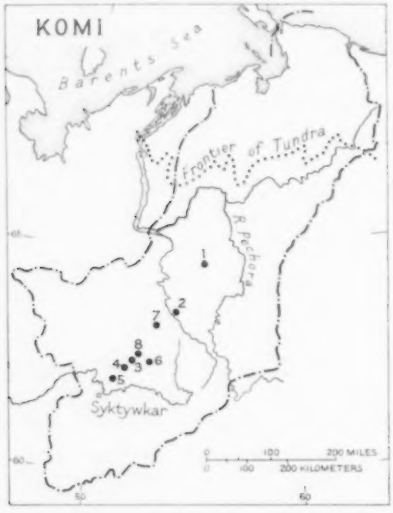

FIG. 2

FIG. 3

FIG. 2—Centrogram of the Komi (Zyrian) Region. Key: centers of 1, area; 2, forests; 3, barley; 4, acreage under crops; 5, corn; 6, lumber; 7, hunters; 8, population.

FIG. 3—Centrogram of the German Volga Autonomous Socialist Soviet Republic (1926). Key: centers of 1, area; 2, forests; 3, acreage under crop; 4, tobacco; 5, orchards; 6, total population; 7, urban population; 8, German population; 9, Russian population; 10, industrial workers; 11, prime movers.

noteworthy; also the southern concentration of winter wheat, barley, and maize; and the decided northern location of buckwheat and oats.

Figure 2, the Komi region, shows a very different type of distribution of the centers. Instead of tending to concentrate in a central area, they are distributed along almost a straight line determined by the center of area and the center of population. The distance between these two centers, as contrasted with their close proximity in Figure 1, summarizes briefly but vividly entirely different relative distributions of the populations over the two areas.

Figure 3 shows the distribution of another group of agricultural and industrial centers, in the German Volga Autonomous Soviet Socialist Republic.

Much more interesting and significant, however, than the status at any particular time is a study of trends as represented by the geographic movement of the center of a given feature over a series of years. This is well illustrated by Figure 4, which shows the location

of eight different centers in the Union of Soviet Socialist Republics at various dates from 1858 to 1932. It may be noted that all the centers except the two for railway transportation show a general tendency to shift southward and eastward, though at widely differing rates and distances. Taken as a whole, they furnish a very significant

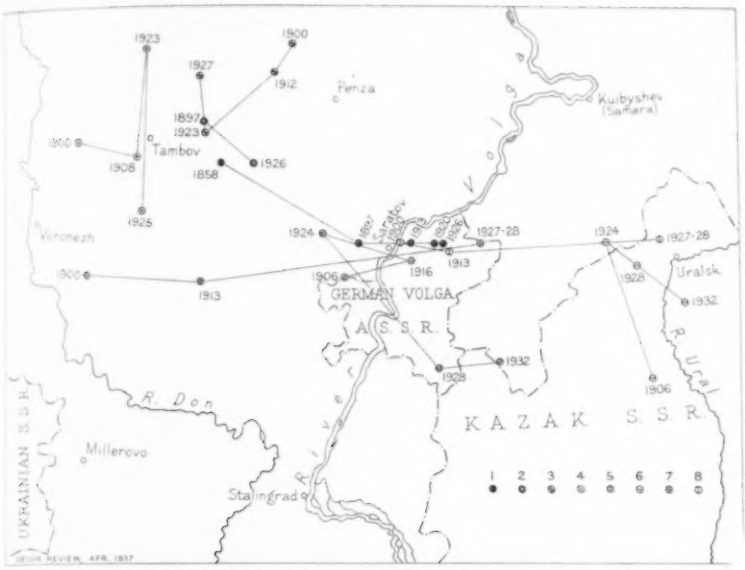

FIG. 4—Centrogram showing trends in the Union of Soviet Socialist Republics as revealed by movements of centers for various years from 1858 to 1932. Key: centers of 1, total population; 2, literate population; 3, persons engaged in industry; 4, horsepower in industry; 5, acreage under crop; 6, cattle; 7, railway system; 8, freight shipments by rail.

summary of general developments—demographic, agricultural, and industrial—in the Soviet Union during the twentieth century. They raise pertinent questions as to the reasons for the regional changes thus portrayed.

Figure 5 shows the location of the center of general population and the center of students enrolled in higher educational institutions in the United States at decennial intervals from 1790 to 1930. The chief features of interest are the steady progress of the center of population westward along the 39th parallel and the fact that the educational center has always been north of the general center. Early in the nineteenth century it was east of the general center, but it has moved westward so much more rapidly that in 1930 it was considerably west of it—a concise reflection of the relatively larger enrollments in recent years in the large universities of the western part of the United States.

Figure 6 gives other examples of the movements of the center of

population. It may be observed that the relative distribution in France has changed only slightly and in Germany still less, though for all Europe there has been a marked eastward trend. On the contrary the movement in Canada and in the United States has been westward. The movement in the northern hemisphere as a whole, in the past century or more, has been definitely away from the Atlantic Ocean and toward the Pacific Ocean.[2] If this tendency continues, it suggests that the Pacific Ocean may well become the chief theater of population concentration and of resultant world interest and relationships. Except for the Russian center, the general movement of the centers has a northerly component, which is in accordance with the "coldward course of progress" hypothesis of S. C. GilFillan.[3]

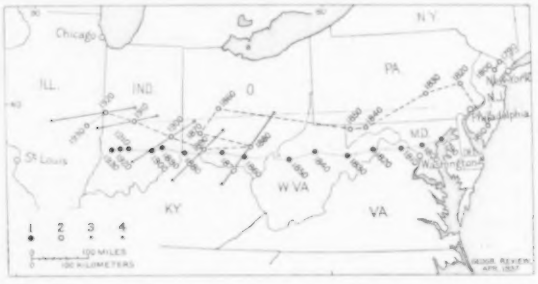

FIG. 5—Centrogram showing movements of the centers of population and higher education in the United States of America from 1790 to 1930. Key: centers of 1, general population; 2, higher educational population (universities and colleges); 3, higher educational population, men; 4, higher educational population, women. (From a study made by Walter C. Eells for publication in the forthcoming Mendeleev Memorial Volume of the Centrographical Laboratory in Leningrad.)

Of course, the direction and volume of the streams of migration during any period are the resultant of highly complex interrelated sets of factors. This resultant, however intricate the causal factors, is expressed by the centrographical method in the motion of a single point. Caution should be observed, however, in using this motion as a basis of prediction. If the same causal factors continue to operate, it forms a valid basis for prediction. If marked changes take place, however, such as war, pestilence, commercial development, and change in form of government, its reliability as a predictive instrument is lessened, if not destroyed. Some long-range prophecies based upon the movement of the center of population have been verified.[4] As a summary of historical fact this movement is excellent; as a method of prediction it must be used with caution.

[2] In both Italy and Australia also during a ten-year period there has been a slight movement of the center of population eastward, in accordance with the same tendency. See C. Gini, M. Boldrini, L. Galvani, and A. Venere: Sui centri della popolazione e sulle loro applicazioni, *Metron*, Vol. 11, No. 2, 1933, pp. 3–102.

[3] S. C. GilFillan: The Coldward Course of Progress, *Political Sci. Quart.*, Vol. 35, 1920, pp. 393–410.

[4] One of the most interesting of these is the series of predictions made in 1872 concerning the probable westward progress of the center of population in the United States. See J. E. Hilgard: The Advance of Population in the United States, *Scribner's Monthly*, Vol. 4, 1872, p. 214; and W. C. Eells, The Center of Population—A Prophecy and Its Fulfilment, *Scientific Monthly*, Vol. 20, 1925, pp. 78–84. Another was made by D. I. Mendeleev, who wrote in 1905 concerning the Russian center of population: "It is possible to state with assurance that it will advance toward the blessed South and East, with their abundance of fertile soil." This also has been fulfilled, as Figure 4 of this article shows.

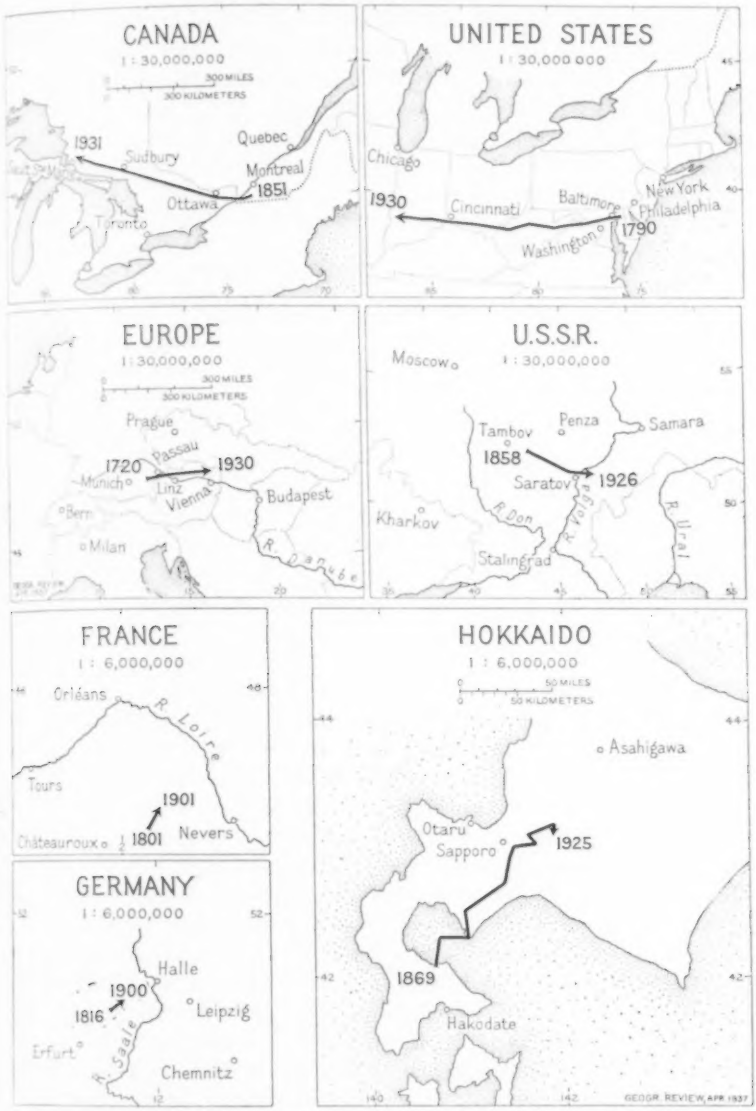

FIG. 6—Examples of trends of centers of population.

MEDIAN CENTER

An unfortunate error on the part of the United States Bureau of the Census in identifying the center of population or mean center with the point of minimum aggregate distance of travel was discovered independently in the United States by W. C. Eells and H. Bossert,

Jr., and in Italy by Gini and Galvani.[5] In the Union of Soviet Socialist Republics confusion of the properties of these two points has been avoided. Thus as early as 1905 D. I. Mendeleev wrote:[6]

> It can be shown that there are cases when the "center of convergence" of all inhabitants does not coincide with a center of population, conceived as a center of gravity. But this coincidence exists, probably, not only in many evident cases, but also, generally, in countries with a large area and a great number of inhabitants. The problem of determining a center of convergence still awaits its full solution.

TABLE I—AVERAGE TRAVEL DISTANCE TO MEDIAN CENTER AND NEAR-BY CITIES, 1920

CITY	AVERAGE TRAVEL DISTANCE (*Miles*)	PERCENTAGE OF DISTANCE TO MEDIAN CENTER	DISTANCE OF THE CITY FROM THE MEDIAN CENTER	
			(*Miles*)	(*Kilometers*)
Median Center . . .	649	100.0	. . .	. . .
Cincinnati, Ohio . .	652	100.5	57	92
Columbus, Ohio . .	653	100.7	85	137
Indianapolis, Ind. .	654	100.9	106	171
Louisville, Ky. . . .	665	102.5	150	241
Cleveland, Ohio . .	675	104.1	200	322
Chicago, Ill.	685	105.7	235	378

Mendeleev's suggestion regarding probable coincidence of the two points in the case of large countries and populations has not proved to be true for the United States, however, where, as is shown below, the two centers proved to be 150 miles apart.

Gini and Galvani have suggested the term "median center" for this point—a term that has met with wider acceptance than Mendeleev's "center of convergence." They have formulated the general solution of the problem of determining this point but have not given practical methods for locating it in specific situations.

Professor N. A. Smirnov has examined analytically the properties of this center, which he has termed a "central point."[7] To aid in determining the location of the median center by mechanical rather than by computational methods, several instruments have been devised by D. I. Mendeleev, Jr. A design of these instruments was presented at the Centrographical Laboratory in 1930. They have been called "planimetrical centrograph," "point centrograph," and "centrographical balance."

[5] For a good summary of the discussion concerning this matter and an English translation of part of the article by Gini and Galvani see "Editor's Note on the Center of Population and Point of Minimum Travel," *Journ. Amer. Statist. Assn.*, Vol. 25 (N.S.), 1930, pp. 447–452.

[6] D. I. Mendeleev, K poznaniyu Rossii (Information on Russia), 3rd edit., St. Petersburg, 1906, p. 99, note.

[7] N. A. Smirnov: O tsentral'noi tochke (The Central Point), *Fizich. Otd. Jurnala Russk. Fiz.-Chim. Obshchestva*, Vol. 39, 1907.

An approximation method of locating this point of minimum travel for the United States in 1920 was worked out by Scates.[8] He found it to be almost exactly on a line between Indianapolis, Ind., and Columbus, Ohio, about 30 miles east of the Indiana-Ohio line and fully 150 miles northeast of the 1920 center of population. It is about 40 miles east of the 1920 intersection of orthogonal median lines, the "median point" considered below. Of the large cities in the vicinity of this median center in 1920, Cincinnati, Ohio, was the closest. The average distance necessary for each person in the United States to travel to reach this median center and several near-by cities was worked out by Scates. His findings are summarized in Table I.[9]

Median Point

The median point for the population of any area is understood to be the point of intersection of two orthogonal lines each of which divides the population into two equal groups. Sometimes this point has been erroneously called the center of population. The median point has definite limitations not characteristic of the other two points that have been considered. One limitation is that it is not unique in location but depends on the choice of direction of the orthogonal axes. This fact was first pointed out by J. F. Hayford, in 1902.[10] The median point becomes unique for any arbitrary selection of axes, the commonest choice being a meridian and a parallel of latitude. It is on this assumption that the United States Bureau of the Census has determined the median point for the United States. For 1920 it was 121 miles northeast of the center of population.

A more serious fault, however, which cannot be removed by any refinement of definition or additional assumption, is that the median point is not necessarily a sensitive center and may be erratic in movement with certain changes of the population. It is very different in this respect from the mean center and from the median center. Thus in the United States if a single individual should move from Chicago to Seattle, a distance of about 2000 miles, the mean center would respond at once by moving westward about one inch. A million people, however, might move from Chicago to Seattle without affecting at all the location of the median point, since both cities are north and west of this point. If a million people moved only a few miles, however, so as to change from the northwest to the northeast or southeast quadrant, the location of the median point would be changed materially.

[8] D. E. Scates, Locating the Median of the Population in the United States, *Metron*, Vol. 11, No. 1, 1933, pp. 49-66.

[9] Scates, *op. cit.*

[10] J. F. Hayford: What is the Center of an Area, or the Center of a Population? *Publs. Amer. Statist. Assn.*, Vol. 8 (N.S.), 1902-1903, pp. 47-58.

Obviously a point whose location is subject to such violent and erratic fluctuations or complete insensitivity according to the chance location of changing population elements is by no means as satisfactory a centrographical index as the mean center, which responds proportionately to the movement of any individuals regardless of their number, location, or direction of travel.

Quartilides, Decilides, and Centrilides

The concentration of population almost wholly in one area and its subsequent uneven spread to other areas, the irregular distribution of industry, of natural resources, of educational facilities, and of land utilization, and many other features often require more detailed analysis than is afforded by the highly concentrated summarizing measures based on any of the centers that have been considered. The essential facts concerning the internal structure and development of a region, developing along different lines in different areas, require a more accurate, detailed, graphical regional analysis. The problem of centrography, therefore, is not only that of constructing centrograms such as those already presented but that of devising polysynoptical graphs of various types. One class of these is explained below. It may well be the starting point of a new line of centrographical activity.

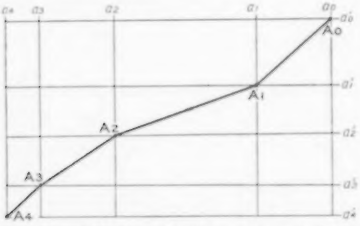

FIG. 7—Diagram showing method of determining quartilides.

Although the median point has severe limitations on its usefulness, as was pointed out in the previous section, a generalization of the method by which it was determined has decided utility for a more refined regional analysis than is possible by the use of a single index point.

Instead of a single north-south line bisecting the population in a given area, three parallel lines may be drawn dividing the population into equal quarters, or nine such lines dividing the population into equal tenths, or 99 such lines dividing it into equal hundredths. If a similar series of east-west lines are drawn, their intersections determine a series of points that Dr. Sviatlovsky has termed "quartilides," "decilides," or "centrilides." The method may be made clearer by a simple diagram illustrating the construction of three quartilides.

In Figure 7, let a_0, a_1, a_2, a_3, and a_4 be five vertical lines dividing the population of the given area into four equal groups. Similarly let a'_0, a'_1, a'_2, a'_3, and a'_4 be a series of horizontal lines dividing the

total population into four equal groups. Then the intersections of corresponding lines define uniquely the three quartilides A_1, A_2, and A_3. A_3 is a point such that three-quarters of the population of the region are north and one-quarter south of it; or three-quarters of the population east and one-quarter west of it.

Figure 8 is a map of the United States on which several sets of decilides (determined by a method analogous to that of the quartilides

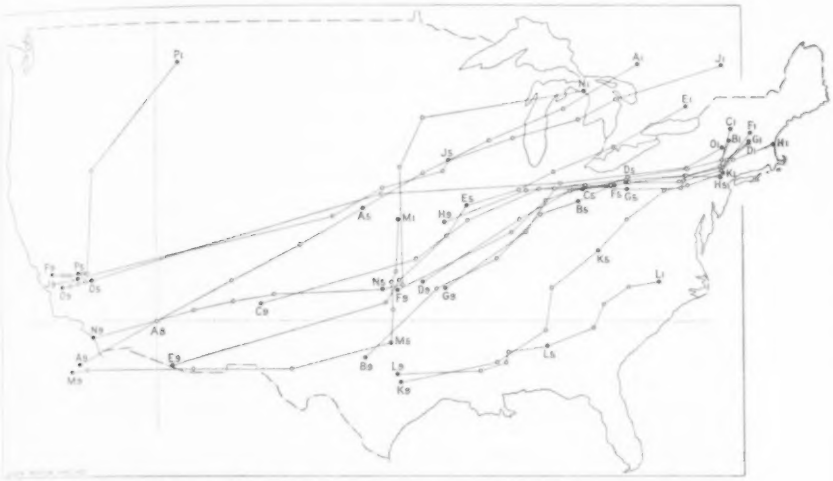

FIG. 8—Centrogram of the United States showing location of decilides of selected elements of population, industry, and agriculture. Key: A, area; B, population; C, national wealth; D, value of manufactures; E, farm products; F, developed horsepower; G, wage earners; H, foreign born population, urban; J, foreign born, rural; K, Negroes, urban; L, Negroes, rural; M, Mexicans; N, Indians; O, Chinese: P, Japanese.

just described) have been plotted, summarizing the distribution of 16 groups of significant industrial and population factors. Only the points A_1, A_5, A_9, B_1, B_5, B_9, etc. are so indicated. A_2, A_3, A_4, A_6, A_7, A_8, etc. can easily be located from these.

As an example of the types of analysis made possible by this method of decilides consider the point A_8, through which the two intersecting dotted lines have been drawn. It is at once evident that, although only 20 per cent of the area of the country is west of this point, this western portion contains almost 90 per cent of the Japanese population of the country (P_1), only a little more than half of the Chinese population (O_5), much less than 10 per cent of the national wealth (C_9), and only a little less than 10 per cent of the farm products (E_9). Similarly, by considering the horizontal line through A_8, south of which 20 per cent of the area lies, it is evident that south of this line are found more than 50 per cent of the Mexicans (M_5), less than 10 per cent of the wealth (C_9), etc.

A similar method may be applied to study the relations between

the regional distributions of any groups of factors. For example, it will be instructive to compare the distribution of the elements A, E, and J with that of P, M, and L, or of L and J with that of K and H.

The power and possibilities of this method of regional analysis are great. If a greater degree of refinement is desired than that obtained by the use of decilides, it is easy to make 20 divisions or, as suggested above, 100 divisions, leading to centilides—a degree of refinement greater than ordinarily profitable.

Conclusion

A number of other methods of centrographical and regional analysis have been developed or refined and utilized at the Mendeleev Centrographical Laboratory, such as differential centers, density profiles, ellipses of inertia, and centers of national economy, but space does not permit a detailed presentation of them at this time.

The scientific work of the past few decades in the fields of geography, astronomy, geophysics, and geobotany has contributed greatly to the development of an extensive theory of centers, such as centers of dispersion, of origin, of action, of area, and of frequency. The development and application of the centrographical method in its statistical sense have been stimulated by these more general concepts of centers.

Two main problems appropriate for treatment by centrographical methods involve variability of regions and types of regions. The centrographical method has distinct potentialities both for the comparative analysis of regions historically (as illustrated in Figs. 4, 5, and 6) and for intensive study of regions on the basis of interrelated factors at a particular time (as illustrated in Figs. 1, 2, 3, and 8).

The centrographical method, of course, is not without its difficulties and limitations. Some of these have been indicated above. The difficulties will doubtless yield to further study as techniques are improved and appropriate advances are made in the related fields of statistical method and geography. The centrographical field offers an inviting challenge to the courage and intelligence of those interested in its further development.

Appendix: Historical Résumé

The United States

The first reliable computation of the center of population of any country or region seems to have been made in the United States, by J. E. Hilgard in 1872.[11] The first official recognition of the concept of center of population is found in the computations carried out under the direction of Francis A. Walker, superintendent

[11] J. E. Hilgard: The Advance of Population in the United States, *Scribner's Monthly*, Vol. 4, 1872, p. 214.

of the ninth census, for publication in the first statistical atlas of the United States.[12] At the same time the position of the center of population was determined for each previous decennial census year since the first one, in 1790. Computation of this center and discussion of its significance have been regular features of the statistical atlases published in connection with subsequent decennial censuses, prepared under Henry Gannett and, later, Charles S. Sloane, as geographers of the census.[13]

In 1910 the center of population of each of the states and the District of Columbia was computed not only for that year but also for 1880, 1890, and 1900. State centers for 1920 were also computed; but unfortunately this half century series is now broken, for the 1930 centers, owing to the need of economy, were not computed.

In connection with the 1920 census the method was extended to determine the centers of the foreign-born, native-white, negro, urban, and rural components of the population. It was further extended into the agricultural and industrial fields through the calculation of the centers of number of farms, farm area, improved acreage, value of farm property, production of cereals, of corn, of wheat, of oats, and of cotton, manufactured products, and wage earners—in most cases for each decennial-census year since 1850.[14]

After the publication in 1930 of an article by W. C. Eells calling attention to an unfortunate error in the United States census regarding an asserted property of the center of population[15] considerable interest developed outside census circles. Griffin has studied certain mathematical properties of a generalized concept,[16] and Scates has developed an approximation method for determining the "median center"[17] mentioned below. Eells has published a series of articles dealing with centers of population in a variety of higher educational fields, in some cases running as far back as 1790.[18]

The United States Geological Survey has determined the positions of the centers of area of the individual states and of the country[19] and centers of such natural resources as potential water power, oil, and coal. These industrial phases have been extended by the determination of centers of electric light and power since 1882.[20]

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[12] F. A. Walker: The Progress of the Nation, 1790–1870, pp. 5–6, *in* Statistical Atlas of the United States, Based on the Results of the Ninth Census, 1870, compiled by F. A. Walker, U. S. Dept. of the Interior, Census Office, 1874, Part 2.

[13] Although the concept has been confined for the most part to official publications, there has been some popularization of it in other sources. See, for example, Henry Gannett's "The Building of a Nation" (New York, 1894), which contains a section on "Center of Population" (pp. 71–74). Several recent works on sociology and population problems include some consideration of the matter.

[14] Statistical Atlas of the United States, 1924, U. S. Dept. of Commerce, Bur. of the Census, Washington, 1925, pp. 7–24 and Plates 120–138.

[15] W. C. Eells: A Mistaken Conception of the Center of Population, *Journ. Amer. Statist. Assn.*, Vol. 25 (N.S.), 1930, pp. 33–40. For summary of the controversy caused by this article see "Editor's Note on the Center of Population and Point of Minimum Travel," *ibid.*, pp. 447–452.

[16] F. L. Griffin: The Center of Population for Various Continuous Distributions of Population over Areas of Various Shapes, *Metron*, Vol. 11, No. 1, 1933, pp. 11–16.

[17] D. E. Scates: Locating the Median of the Population in the United States, *Metron*, Vol. 11, No. 1, 1933, pp. 49–66.

[18] Walter Crosby Eells: The Center of Population of Higher Education, *School and Society*, Vol. 24, 1926, pp. 339–344; *idem:* The Center of Population of Engineering Education, 1900–1930, *Journ. of Engineering Education*, Vol. 25, 1935, pp. 662–669; *idem:* The Center of Population of Medical Education, 1870–1930, *Journ. Assn. of Amer. Medical Colleges*, Vol. 10, 1935, pp. 331–337; *idem:* The Center of Population of Pharmaceutical Education, 1870–1930, *Journ. Amer. Pharmaceutical Assn.*, Vol. 24, 1935, pp. 868–871; *idem:* The Center of Population of Dental Education, 1870–1930, *Journ. Amer. Dental Assn.*, Vol. 23, 1936, pp. 473–476; *idem:* The Center of Population of Higher Educational Libraries in the United States, 1870–1930, *Library Quart.*, Vol. 6, 1936, pp. 175–181; *idem:* The Center of Population of Legal Education, *Amer. Bar Assn. Journ.*, Vol. 22, 1936, pp. 61–62; *idem:* The Center of Population of Theological Education, 1870–1930, *Christian Education*, Vol. 19, 1936, pp. 327–331.

[19] E. M. Douglas: Boundaries, Areas, Geographic Centers, and Altitudes of the United States and the Several States, 2nd edit., *U. S. Geol. Survey Bull. 817*, 1930.

[20] Business Facts for Electrical Men, *Electrical World*, Vol. 81, 1923, p. 255.

Union of Soviet Socialist Republics

The first Russian work in the field of centrography was written in 1887 by A. A. Tillo.[21] In 1906 appeared the important work on demography by D. I. Mendeleev,[22] in whose honor the Mendeleev Centrographical Laboratory was founded. The importance of his contributions is suggested by the contents of Chapter 2 of this volume: notions on civic centers, centers of area and of population, median point, practical methods of determining centers, tables of centers for 1897, formulas. The "Supplement" (1907) includes an interpretation of the larger aspects of the questions thus treated under the title "Russia in Its World Relationship."

In 1915 Professor B. Weinberg reported the positions of the center of area and the center of population of Russia at intervals from 1613 to 1913. Since 1925 E. E. Sviatlovsky has devoted the main part of his time to the Russian Geographical Society. Its Centrographical Laboratory, mentioned above, was organized by him in 1925, and he has served as its director from the beginning to 1935. In 1927, 1928, and 1932 this laboratory issued *Bulletins* under his editorship that contained a variety of centrographical and statistical contributions both national and international in scope. The bulletins included an extensive bibliography of more than 200 titles covering the literature of the subject in all languages with the exception of the Italian contributions, which were not available until 1933. In 1930 Dr. Sviatlovsky's "Principles of Centrography" and an accompanying paper were published in the *Izvestia* (Vol. 62) of the Russian Geographical Society. The "Principles of Centrography" deals with the following topics: general notions, properties of centers, the study of regions, and applications to economic geography. A further review of the centrographical method by the same author was published in *Allgemeines Statistisches Archiv*, Vol. 24, 1934, pp. 21–40.

Important contributions to the work of the Centrographical Laboratory have also been made by A. A. Bobrik, V. Pokshishevsky, D. Zinserling, D. I. Mendeleev, Jr., G. Kolosoff, and B. Weinberg. The Centrographical Laboratory has determined not only various centers of population but also certain economic, sociological, and industrial centers of the Soviet Union and of various regions in it for the years 1858, 1897, 1900, 1912, 1913, 1920, 1926, 1927–1928, and 1933.

In 1934 a Mendeleev memorial volume was prepared, but unfortunately the publication of it has been delayed. It is to contain contributions by H. Radlicz of Warsaw, Professors C. Gini of Rome and L. Galvani of Naples, Professor Walter C. Eells of Stanford University, California, and Professor A. C. Lane of Boston; as well as by members of the staff of the Centrographical Laboratory.

The laboratory has under consideration the advisability of publishing a special journal in the field, possibly with the title *Studies in Centrography*.

Italy and Other European Contributors

A number of important centrographical studies, some of them very extensive, have been published in *Metron*, the international review of statistics of which Professor Corrado Gini, director of the Institute of Statistics of the University of Rome, is editor. During the World War Professor Gini prepared, with M. Boldrini, an article on the center of population in Italy. The general solution of the problem of determining the point of minimum aggregate travel for any population was presented and discussed by Galvani and Gini in 1929.[23]

[21] A. A. Tillo: Raspredelenie tsentrov materikov na poverkhnosti zemnogo shara (Distribution of the Centers of the Continents on the Surface of the Earth), *Izvestiya Imp. Russkago Geograficheskago Obshchestva*, Vol. 23, 1887, pp. 750–753).

[22] D. I. Mendeleev: K poznaniyu Rossii (Information on Russia), six editions in 1906, 7th edit. in 1912.

[23] C. Gini and L. Galvani: Di talune estensioni dei concetti di media ai caratteri qualitativi, *Metron*, Vol. 8, No. 1–2, 1929, pp. 3–209.

In 1933 Professor Gini and associates published an extensive review of centrographical developments in other countries and a mass of data and results of computations of the positions of various significant centers in Italy, the product of some fifteen years of work by these scholars.[24] Professor Galvani has published several other articles in this field,[25] and further contributions have been made by Marinelli[26] and Uggè.[27]

Several important studies have been made in other European countries. In Germany the earliest one noted is that of Wegemann, in 1903.[28] Other German contributions before the World War were made by Zemmrich[29] and Mayr.[30] Since the war consideration has been given to the centers of population of Germany, Württemberg, and Saxony; and important theoretical contributions have been made by Burkhardt[31] and Flaskämper.[32]

Halina Radlicz determined the center of area of Poland in 1931, and her paper was accompanied by one by E. Szturm de Sztrem.[33] Other Polish contributions have been made by R. Niewiakowski[34] and J. Haliczer.[35] The positions of the center of population in France in 1801 and 1901 were published in 1907.[36] A contribution to the centrography of Belgium was made in 1935.[37] In Sweden Linders considered the center of population in 1910 and 1920 and related its movement to a fundamental ellipse.[38]

Other Countries

In Japan Professor Kumao Takaoka and Misao Aramata of the Hokkaido Imperial University in Sapporo have determined the center of population and median

[24] C. Gini, M. Boldrini, L. Galvani, and A. Venere: Sui centri della popolazione e sulle loro applicazioni, *Metron*, Vol. 11, No. 2, 1933, pp. 3–102.

[25] L. Galvani: Sulla determinazione del centro di gravità e del centro mediano di una popolazione, con applicazioni alla popolazione italiana censita il 1° dicembre 1921, *Proc. Internatl. Congr. for Studies in Population, Rome, 1931*, Vol. 10, Rome, 1934, pp. 121–151; *idem:* I centri del territorio e della popolazione italiana (1931) e quelli della popolazione industriale e commerciale (1927), *Compendio Statistico Italiano*, Istituto Centrale di Statistica, Vol. 7, Rome, 1933, pp. 315–328.

[26] Olinto Marinelli: L'Italia demografica e il suo centro di popolazione, in his "Curiosità geografiche," Milan, 1928, pp. 143–153.

[27] Albino Uggè: Il centro di popolazione dell'Italia nei nuovi confini, Milan, n. d.

[28] G. Wegemann: Der Bevölkerungsschwerpunkt des Deutschen Reiches, *Petermanns Mitt.* Vol. 49, 1903, pp. 210–212.

[29] Johannes Zemmrich: Die Bevölkerungsmittelpunkte im Königreich Sachsen, *in* Zu Friedrich Ratzels Gedächtnis, Leipzig, 1904, pp. 463–471.

[30] G. von Mayr: Statistik und Gesellschaftslehre, 2nd edit., Vol. 2, Tübingen, 1926, p. 85.

[31] F. Burkhardt: Der statistische Schwerpunkt und seine Bedeutung für Theorie und Praxis, *Allgemeines Statistisches Archiv*, Vol. 19, 1929, pp. 473–483.

[32] P. Flaskämper: Beitrag zur Logik des statistischen Mittelwerte, *Allgemeines Statistisches Archiv*, Vol. 21, 1931, pp. 379–404.

[33] Halina Radlicz: Les méthodes centrographiques et leur application au territoire de la Pologne (in Polish, with French résumé), *Rev. Trimestrielle de Statistique*, Office Central de Statistique, Vol. 8, 1931, pp. 1–12; Edward Szturm de Sztrem: Observations sur la méthode centrographique (in Polish), *ibid.*, pp. 13–15.

[34] Romuald Niewiakowski: Centra terytorjalne i ludnościowe w Polsce (Les centres du territoire et de la population en Pologne), *Comptes Rendus II Ime Congrès des Géographes et Ethnographes Slaves, dans le Royaume de Yougoslavie, 1930*, Belgrade, 1933, pp. 149–150.

[35] Josef Haliczer: The Population of Europe, 1720, 1820, 1930, *Geography*, Vol. 19, 1934, pp. 261–273.

[36] *Album Graphique de la Statistique Générale de la France*, Ministère du Travail et de la Prévoyance Sociale, Paris, 1907, p. 6. See also "Résultats statistiques du recensement général de la population effectué le 24 mars 1901," Vol. 1, Introduction, Paris, 1904, p. 221; and P. Meuriot: Du centre mathématique d'une population (de villes), *Journ. Soc. Statistique de Paris*, Vol. 43, 1902, pp. 218–219. See also A. Berget: Sur la position exacte du pole continental de la terre, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 156, 1913, pp. 1714–1716.

[37] A. Olbrechts: Le centre de population de la Belgique, Mélanges Ernest Mahaim, Liège, Vol. 1, 1935, pp. 216–220.

[38] F. J. Linders: Über die Berechnung des Schwerpunkts und der Trägheitsellipse einer Bevölkerung, *Metron*, Vol. 11, No. 1, 1933, pp. 3–10.

point of the island of Hokkaido for twelve different years between 1869 and 1925.[39] Aramata has also worked out centers of agriculture of Hokkaido.

The most significant study in Canada has been made by H. E. M. Kensit. It covers not only population but centers of industry and water power since 1851.[40] Australian centers of population in 1911 and 1921 have been found in connection with the decennial censuses.[41] Centers of certain Indian states at various decennial censuses have been determined.[42]

Several significant contributions were made at the Slavonic geographical congresses, notably those of 1930 and 1933, at the session of the International Institute of Statistics held at Tokyo in 1930, and at the International Geographical Congress at Warsaw, in 1934.

[39] K. Takaoka and M. Aramata: The Center and Median Point of Population in Hokkaido (in Japanese), Sapporo, 1931. See also Mark Jefferson: A Daytime Census in Tokyo and the Center of Population in Hokkaido, *Geogr. Rev.*, Vol. 23, 1933, pp. 333–334.

[40] H. E. M. Kensit: The Movement of the Centres of Population, Industry and Developed Water Power in Canada, *Engineering Journ.*, Engineering Inst. of Canada, Vol. 12, 1929, pp. 605–609. See also his "The Centre of Population Moves West," *Canadian Geogr. Journ.*, Vol. 9, 1934, pp. 262–269. "Analysis of the Stages in the Growth of Population in Canada" (Ottawa, 1935) containing the location of centers of population of Canada and the provinces (1851–1931) was carried out under the direction of Mr. M. C. MacLean, Dominion Bureau of Statistics.

[41] Census of the Commonwealth of Australia, 1911, Vol. 1, Melbourne, 1917 (?), p. 426; *ibid.*, 1921, Vol. 2, Melbourne, 1927 (?), p. 365 of "Statistician's Report," by C. H. Wickens.

[42] Census of India, 1921, Vol. 24, Rajputana and Ajmer-Merwara, Part 1, Calcutta, 1923, pp. 2–3; *ibid.*, Vol. 25, Travancore, Part 1, Trivandrum, 1922, pp. 10–11; *ibid.*, 1931, Vol. 5, Bengal & Sikkim, Part 1, Calcutta, 1933, pp. 6–9.

COMMERCIAL AVIATION IN THE AMERICAN MEDITERRANEAN*

Carl Hanns Pollog

ONE of the great advantages of the airplane as compared with ground transport is the possibility of using it over land and water. There are, of course, different types of planes for flying over land and for flying over water; but whereas seaplanes are rather infrequently used on short overland portions of airways and amphibians are seen on only a few airlines, day by day landplanes fly over a considerable number of miles of water. On routes with scheduled air services the distances to be flown over water by landplanes are generally small:[1] it is, however, just such a connection that causes annoyance and additional expense when ground transport only is used. If you travel, or ship goods, from San Francisco to Bucarest, it will generally be of no great importance that you, or your goods, twice have to change the means of transport, but between London and Brussels the matter assumes a different aspect. In some cases expensive engineering works have been undertaken to secure, so far as possible, unbroken land or water passage on important traffic routes; for example, the viaduct to Key West, the Hindenburg Dike to the Isle of Sylt, the new bridge over the Little Belt, and the Panama, Welland, Suez, and Kiel Canals. There is no need for such constructions in transport aviation.

Now there are certain regions where the interpenetration of land and water assumes especially large proportions and where, therefore, the plane may best show its superiority over ground transport. These regions are the European, Australasian, and American Mediterraneans, which together have an area about one and one half times that of the United States. To this area must be added a certain portion of the adjacent continents; for the water surfaces do not create any traffic, they only carry it: they are the deserts or voids to be bridged between the land regions, which furnish the objects of traffic. There is not only a hydrological but also a traffic catchment area of the Mediterraneans, the extent of which, however, would be difficult to evaluate. Within the Mediterraneans the distribution of land and water is of prime importance for transport aviation; for peninsulas, islands, and archipelagoes are not only outliers of the traffic-creating continents but also most useful steppingstones, reducing the over-water distances to be bridged by nonstop flights. Instead

*This paper is a condensed version of part of a comparative study of commercial aviation in the three Mediterranean regions.

[1] The largest over-water stages flown by landplanes are at present Rhodes-Alexandria (Koninklijke Luchtvaart Maatschappij, about 375 miles) and Koepang-Port Darwin (QANTAS Empire Airways, about 500 miles); but seaplanes are scheduled to replace the landplanes on the whole Singapore-Port Darwin leg.

of figures for the coastal development of the three Mediterraneans, the values of Krümmel's "insulosity"[2] may perhaps serve the present purpose. The "insulosity" is the percentage of the area of a sea that is occupied by islands; it is 3.6 per cent for the European Mediterranean, 15.7 for the Australasian, and 5.0 for the American.

Physical Conditions and Air Transport

Any form of transport is dependent on three geographical factors: its existence is made possible or impossible by physical geography, warrantable or unwarrantable by economic geography, and feasible or unfeasible by political geography.[3] More than any other form of transport, aviation has emancipated itself from the tyranny of the first named—physical geography. Modern planes, carrying a reasonable amount of paying load, are able to make nonstop flights of 500 to 2000 miles, that is to say, more than the greatest over-water distances in any of the three Mediterraneans. The vertical distribution of land masses has also lost much of its significance. The Rocky Mountains, the Andes, and the Alps are crossed by scheduled air services during all seasons and in certain cases even by night. Places at sea level are connected by direct flights with others at altitudes of 10,000 feet or more. The dependence of aviation on topography is greater in regard to airports. A good flying field ought to have a firm, level surface measuring at least half a mile in every direction, and there ought to be no obstacles higher than a certain angle of elevation from the border of the field. But where there is a more or less well defined regime of the winds, the diameter length given above, or specially prepared runways, will be required only in the direction or directions of the prevailing winds. Modern technical means make the possibility of establishing a suitable flying field less a question of physical geography than of finance. For landing and taking off seaplanes require a sheet of water whose minimum diameter should be rather larger than the figure given for flying fields; moreover, the water must be neither too rough nor too smooth. Natural difficulties could be overcome by catapulting the seaplanes, though up to now this method has been used only on shipboard. In passing, a curious phenomenon may be noted. At certain places on tropical coasts the water seems to be more "sticky" than elsewhere; at least seaplanes at such places have been unable to take off under conditions that elsewhere did not present unsurmountable difficulties.[4]

The meteorological elements have also lost some of their im-

[2] Otto Krümmel: Handbuch der Ozeanographie, 2nd edit., Stuttgart, 1907, Vol. 1, p. 32.

[3] Formulated in my book "Der Weltluftverkehr: Seine Entwicklung, Geographie und wirtschaftliche Bedeutung," Leipzig and Berlin, 1929, p. 1.

[4] Cf. Sarmento de Beires: Asas que naufragam, Lisbon, 1927, Chs. 4 and 5; R. Franco and J. Ruiz de Alda: De Palos al Plata, Madrid, 1926, p. 140; Francesco de Pinedo: Amerikaflug, Zurich and Leipzig, 1928 p. 140.

portance. Of course, the great climatological zones will always affect aviation in various ways. The subtropical belts of high pressure are the most favorable and, in places, even really ideal regions for aviation: conditions within the tropics show regional and seasonal variations but can generally be considered as more or less good, or at least moderate; variations are much greater in the temperate zones, which can be classified only as moderate to bad; and in the polar regions conditions are, with a few local and seasonal exceptions, bad to outright prohibitive. But with regard to the problems created by a single meteorological element, modern science and technique make continual progress. The speed of aircraft will always be increased by a tail wind and decreased by a head wind, but the relative importance of this difference decreases with the increase of the normal speed of planes, which for certain types is already 250 miles an hour, or more than three times the velocity of a wind of force 12 on Beaufort's scale. This speed also enables the plane to go round or rapidly across areas of bad weather. Lighting of airports makes take-off possible in fog and darkness; and, if the necessary radio equipment is added, even landing under the same conditions is feasible, though more difficult. Radio beacons and blind-flying equipment enable the pilot to maintain his course without sight of the ground or over ground—water, deserts, steppes—without distinguishing marks. The danger of ice formation on aircraft has been substantially overcome by the use of pneumatic devices: moreover the meteorological service is able to indicate the areas and altitudes where it will exist. The effects on planes of tropical heat and humidity, voracious ants, etc. are diminished by the increasing use of metal in aircraft construction. The heaviest tropical rains cause only slight damage to metal airscrews. Wooden propellers, on the other hand, often are badly battered and splintered; for it must be borne in mind that the propeller tips rotate with speeds of 200 to 500 miles an hour. Aviation, like any other form of transportation, will never be completely independent of meteorological influences; but the reliability of air service today depends not so much on the climate of a country as on the means available for establishing an appropriate ground organization and purchasing the type of aircraft best suited to individual conditions. This is not to say that technical progress has made consideration of physical geography unnecessary. On the contrary, many disappointments, useless expense, and even loss of human life could have been avoided if the physical geographer and the meteorologist had been consulted in projecting certain airlines.

Economic and Political Bases of Aviation

The economic bases of commercial aviation are much the same as those of other methods of transport. Traffic will spring into being

only where there is a sufficient demand for service and a supply of passengers, mail, and goods. A traffic road—to use this word in its widest sense—will cross "traffic voids" only if the demand for communication between its two ends is great enough. But often it will prefer to make rather large detours if they permit the picking up of additional intermediate traffic. Often, too, airlines have been established where purely economic considerations would not justify their existence and a political motive must be looked for. Such lines may eventually lose their exclusively political character; for in aviation, as in other forms of transport, trade is likely to follow the flag. But the creation of commerce under such circumstances is comparatively rare, and generally politics are more a hindrance than a stimulus to commercial aviation.

Every country has jurisdiction over the aerial space above its national territory; and the smaller a country, the more anxious it often is to maintain these rights. For example, Lithuania for many years required air passengers to have transit visas even if the plane in which they traveled crossed her territory without landing. Although it has been much advocated, there is no such thing as a "three-mile limit" in the air—principally for military reasons. Political units of continental extension, notably the United States and Soviet Russia, are favored in every respect with regard to air traffic, but most other states of the globe, even if styled Great Powers in the age of steam, either are too small to support a reasonable commercial aviation within their own boundaries or have outlying possessions to reach which foreign territory must be crossed. The manifold problems of currency, customs, passport, immigration, and sanitary laws and like regulations would seem to put enough handicaps in the way of the establishment of an international airline. But there is more: most countries today have a state-subsidized aviation company enjoying a legal, a virtual, or at least an approximate monopoly that is being used as an economic or political weapon. Thus a country in most cases will allow a foreign airline to pass over its territory only if its own service is conceded a financial or operational participation or other compensation is offered. Especially in Europe many airways are flown by companies of two different nationalities or more. In the summer of 1933 these airways covered 21.9 per cent of the air mileage and 35.0 per cent of the number of miles scheduled to be flown a day. The record is held at present by the leg Vienna-Budapest, over which in the summer of 1936 Austrian, British, Czechoslovak, Dutch, French, German, Hungarian, and Italian companies were operating. A good example of reciprocity may be seen in the Anglo-Italian convention of 1934, which remained in force during the Abyssinian war in spite of the tension between Great Britain and Italy, though under its stipulations Italian planes regularly land at Malta.

one of the most important strategic and fortified points of the Empire. Great Britain is entitled to operate scheduled air services over the routes (France to) Rome to Naples to (Malta to) Tripoli to Tobruch and farther and Naples to Brindisi and farther, or any combination of these routes, and to make use not only of the Italian airports already mentioned but also of Milan, Rimini, Benghazi, Rhodes, and Castellorizzo. Italy, on the other hand, has the right to run airlines to or through Great Britain, Gibraltar, Malta, Cyprus, Aden, British Somaliland, Palestine, and Transjordania and to use, for this purpose, every flying field of these countries that is open to civil aviation. With a few restrictions regarding only certain customs questions the same right applies to the Anglo-Egyptian Sudan. The convention is of importance for the British services to India, Australia, and South Africa and has made possible first an Italo-British coöperation for a service from Italy to Eritrea and Italian Somaliland and later an all-Italian service between Rome and Addis Ababa. No wonder, therefore, that commercial aviation is often a maze of compromises, international treaties, pooling, and other agreements between companies, all following the policy of *do ut des*.

The American Mediterranean: Climate

The climate of the American Mediterranean may be described as intermediate between the prevailing Etesian climate[5] of the European Mediterranean and the monsoon climate of the Australasian Mediterranean. More precisely, this is the region of transition from equatorial and tropical to subtropical and temperate climates. The equatorial climate—continually wet, but with two well defined rain maxima at the equinoxes—occupies only a small territory, the southernmost part of Central America and the west coast of South America. Nearly all the rest of the region belongs to the tropical climate, the uniformity of which, however, is disturbed by the trade winds. The windward, north and east, coasts have a climate not very different in effect from the equatorial climate as regards rainfall: generally, however, summer is the rainy season. The amount of precipitation decreases toward the northwest, so that a desertic climate reigns west of the 110th meridian. Another climatological divide follows approximately the meridian of Tampico northward; east of this divide also there is rain in all seasons, though not the equatorial type of this regime but a transition between the east-coast subtypes of the subtropical and temperate climates. The boundary between these two is the 30th parallel, which makes itself felt also in the western dry region. Like that of the climate of the American Mediterranean, the

[5] Following Hettner's classification of climates (Alfred Hettner: Die Klimate der Erde, Leipzig and Berlin, 1930).

European Mediterranean is favorable for aviation; the climate of the American Mediterranean, however, improves from south to north and from east to west, the contrary of the situation in the European Mediterranean. The climate of both regions is more uniform in summer than in winter; but, whereas this means a general improvement in the European Mediterranean, rather the reverse is true of the American region. Conditions are not so favorable in the Australasian Mediterranean.

The American Mediterranean cannot rival the other two Mediterraneans with regard to natural airways. Whereas in the European Mediterranean there are a large number of bridges formed by peninsulas and islands and whereas the Australasian region is specked with islands large and small, two parts of the American Mediterranean, the Gulf of Mexico and the Caribbean Sea, are practically without islands. There is only one natural transverse route, that connecting Florida and Yucatan by way of western Cuba; other natural routes circumscribe the region. It has, roughly, the shape of a parallelogram. The short sides, the Gulf coast of North America and the north coast of South America, run east and west, offering easy air routes almost without leaving the land. The long sides, Mexico and Central America and the Antillean chain, run about northwest and southeast. Except for the portion south of the 10th parallel, Central America is broad enough to offer room for two parallel airways, one on the Atlantic side and one on the Pacific; and northwest of the Isthmus of Tehuantepec Mexico is so broad that it can support a whole network of airlines of continental development. On the north half of the east side there are also two parallel natural airways, Cuba and the Bahamas offering each a connection between Florida and Haiti. Jamaica occupies an isolated position. The over-water distances on the natural air routes average only 30 to 60 miles and, except for the Strait of Yucatan, which is nearly 200 miles wide, are nowhere more than 125 miles.

The politico-geographical conditions of aviation in the American Mediterranean differ fundamentally from those in the other Mediterraneans. Its coasts and islands are divided among 22 political organisms,[6] of which 13 are sovereign states. With the exception of the French West Indies, all have air connections, and 12 possess aviation companies of their own. In sharp contrast with the manifold political interests in the other Mediterraneans, commercial aviation in the American Mediterranean is governed to an overwhelmingly large extent by a single power, the United States. Her colors fly over a whole side of the parallelogram and also at several strategic points of the land and island bridges: Puerto Rico, the Virgin Islands, the Canal

[6] The insular possessions of Great Britain (Jamaica and the Bahamas excepted), and, Holland taken each as a unit. In the European and Australasian regions there are 26 and 18 units respectively.

Zone. But the aeronautical activity of the United States covers more than her own territory, as the map, Figure 1, shows. Everywhere in the region long-distance connections are exclusively, and local lines are to a large extent, in the hands of American aviation companies or at least of enterprises that, though possessing *de jure* another nationality, are governed or influenced by American capital. Moreover, almost the entire responsibility for this American expansion rests with a single enterprise, the Pan American Airways system (PAA) and its ramifications:[7]

1. Mother company: Pan American Airways, Inc., operating in the West Indies, Central America, and northeastern South America.
2. Affiliated companies:
   a) Cía Mexicana de Aviación S.A.
   b) Pan American Grace Airways, Inc., operating between Cristobal and Montevideo by way of Santiago and Buenos Aires
   c) Panama Airways, Inc.
   d) Panair do Brazil
   e) Cía de Aviación Pan American Argentina
   f) Pacific Alaska Airways
3. Companies with a share of PAA capital:
   a) Servicios Aéreos de Guatemala S.A. (not operating now).
   b) Urabá, Medellín & Central Airways, Inc., connecting the Canal Zone with Colombia
   c) Cía Nacional Cubana de Aviación S.A.
   d) China National Aviation Corporation

The Great Inter-American Routes

Today Pan American Airways is, among all aviation enterprises of the world, not only the one operating over the greatest mileage but certainly also the one with the greatest capitalization. It has at present no rival to speak of in the American Mediterranean.

The United States was the third country to organize an experimental air-mail service,[8] but only in 1926 did she take up commercial aviation in earnest. Progress was rapid; by 1929 she had gained the first place among the aviation powers of the world, till then occupied by Germany. It is not necessary here to relate this development in detail, but it must be noted that it was, of course, much favored by the economic prosperity of those years. The economic depression that began in 1929 caused, in the aviation of all countries, many changes and a retardation of progress, but no real retrogression, and it would be wrong to say that it has been detrimental to commercial aviation; on the contrary, the rising storm carried away much chaff, leaving the sound grains. This is shown especially well in the case

[7] Some companies not operating in the American Mediterranean are listed here in order to give a complete survey of the Pan American Airways system.

[8] The first scheduled (military) air mail service was inaugurated by Germany on the route Berlin-Hanover-Cologne, February 15, 1918.

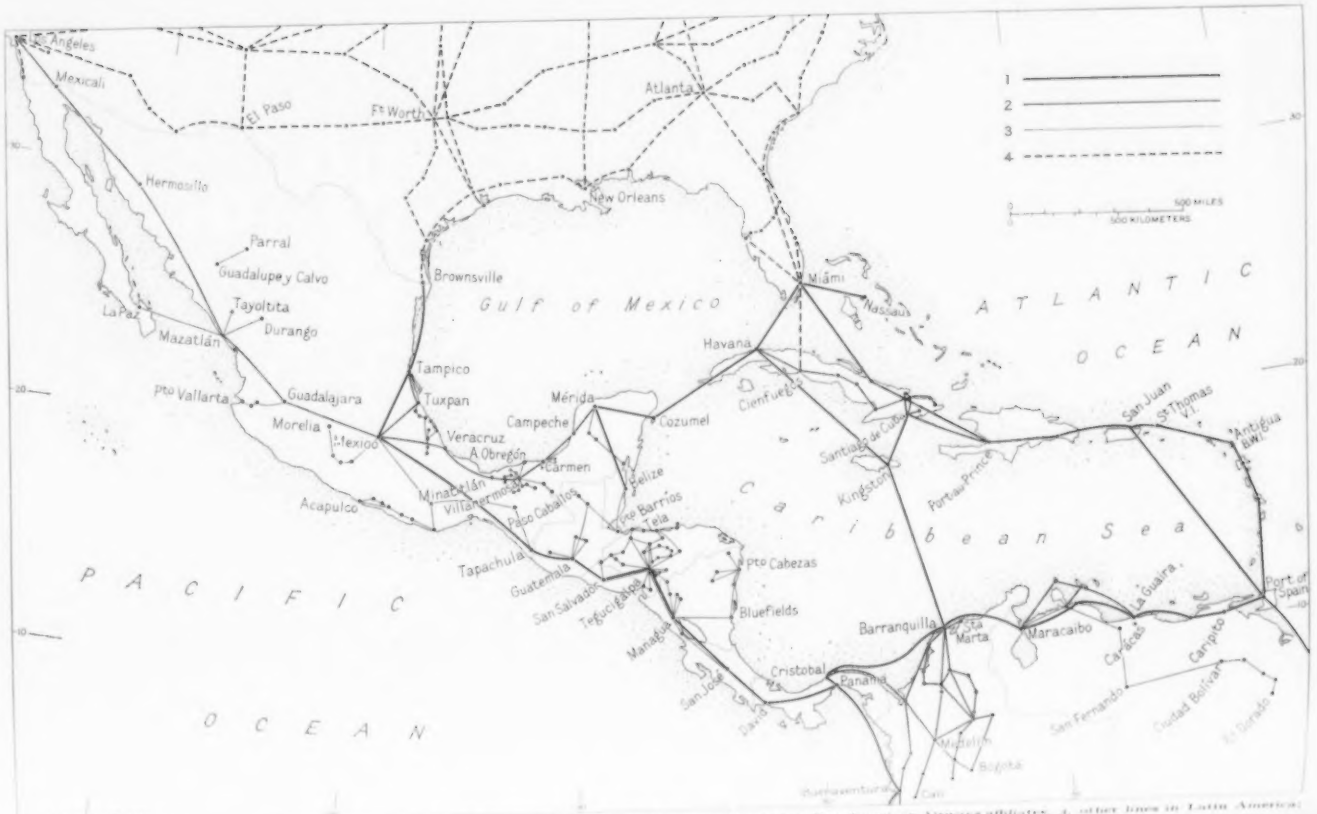


FIG. 1.—The American Mediterranean showing the principal airlines. Key: 1, Pan American Airways; 2, Pan American Airways affiliates; 3, other lines in Latin America; 4, lines in the United States. Scale approximately 1 : 32,500,000.

of the United States airlines to Latin America: their expansion began, it is true, during the boom period, mostly in the last months and even weeks before the "Black Friday," but their development and consolidation belong entirely to the slump period.

The first American airline in the region of the American Mediterranean was opened in 1923: the short foreign air-mail service New Orleans to Pilottown, on which no passengers were carried. It was discontinued in 1934. Several experimental services, touching Key Largo or Key West or both en route, preceded the definite establishment of the connection between Miami and Havana in 1929; the following year saw the Gulf cities of New Orleans, Galveston, and Brownsville being connected with the network of lines coming into existence in the interior of the country. In 1929 there was a real crowding of airline inaugurations: January, Miami to Nassau and Miami to San Juan, P. R.; February, Miami to San Salvador to Cristobal, C. Z.; March, Brownsville to Mexico City; June, Cristobal to Port of Spain; August, Cristobal to Lima to Santiago to Buenos Aires to Montevideo; September, Mexico City to San Salvador and San Juan to Port of Spain to Paramaribo. This is nearly the entire Pan American Airways network of today in the American Mediterranean region; of important connections, only Miami to Cienfuegos to Kingston to Barranquilla and Veracruz to Mérida were opened later (1930), and a few routes were replanned. It is a remarkable fact that Pan American Airways flies more miles with seaplanes than any other aviation company and is the only enterprise to use amphibians over long routes. In the American Mediterranean region landplanes are used only on the lines Brownsville to Mexico City to San Salvador to Cristobal and Mexico City to Veracruz to Mérida and on the lines in western Mexico, Cuba. Amphibians ply between Cristobal and Medellín and are used on the routes Cristobal to Lima, Peru, Cristobal to Port of Spain, and Miami to Havana to Mérida to Belize partly in turn with large seaplanes, which are used exclusively on all the other important routes.

A comparison of the airlines actually in operation with the natural airways will reveal the existence of a long over-water stage that was not included in the discussion of physical conditions: Kingston to Barranquilla, 500 miles (3¾ flying hours). It was chosen in order to have a rapid connection with the Canal Zone. By this route the distance between Miami and Cristobal is under 1800 miles, by the other route, through Central America, 2260 miles; the first route requires no overnight stop, the second one required two and passengers are no longer routed this way. There are no airlines between Haiti and the peninsulas of Goajira or Paraguaná, though the over-water distances here are shorter, because there is no demand for such services. It should be remarked that only the independent West Indian

Fig. 1.—The American Mediterranean showing the principal airlines. Key: 1, Pan American Airways; 2, Pan American Airways affiliates; 3, other lines in Latin America; 4, lines in the United States. Scale approximately 1 : 35,000,000.

republics and American and British islands are served by Pan American Airways; the Dutch and French colonies are avoided.[9] The Netherlands and France are planning connections of their own between the mother countries and the West Indian possessions.

The lines on the western fringe of the American Mediterranean show a certain disregard of the coasts. The reason is understandable; with only a few exceptions the coasts of the Gulf and of the Caribbean Sea are, in respect of economic, and therefore also transport, geography, less important than, not the Pacific coast, but the interior highlands and the Pacific slope. Therefore the airlines prefer to make detours, some of which are by no means negligible, to meet an additional offer of transport objects. There are also political reasons; for the governments of all the Central American republics made the concession dependent on the capitals' being served by the main line. Even in Venezuela there is a certain favoring of the interior, for the route leaves the coast to include Maturín and Caripito; on the other hand, the short branch line La Guaira to Carácas was discontinued in view of the good rail and road connections.

Minor Airlines

In comparison with these great inter-American aerial thoroughfares all other airlines shown on the map are of minor importance. But before they are discussed a few words must be said of Latin American aviation policy. There was a time when it might have been expected that the United States would have a virtual monopoly of commercial aviation in the entire American Mediterranean region and even in many South American countries. But during the past years a tendency has been observed in the Latin American republics to reduce the paramount influence of the great northern sister. Mexico and Venezuela especially have passed aviation laws that, although not intended to bar completely the immigration of foreign (i.e. American) capital and enterprise—by which measure they certainly would cut into their own flesh—are designed to assure the national character of aviation companies serving the national territory. It must be acknowledged that the Mexican law did not paralyze the development of commercial aviation: the three great northern airlines, from San Antonio, El Paso, and Tucson to Mexico City, having fallen victims to the depression, in 1934 new services between Los Angeles and the Mexican capital were inaugurated by Aerovías Centrales and Líneas Aéreas Occidentales (companies now dissolved). The line between Los Angeles and Mexico is important, since it brings Central and South America for the first time into direct air connection

[9] Willemstad, Curaçao, which at first had been served by Pan American Airways, has been abandoned in favor of the Venezuelan port of Cumerebo.

with the Pacific coast up to Vancouver and with the Rocky Mountain region as far as Idaho and Montana. To the international routes has been added, since 1933, a network of internal airlines, many of which, it is true, are of purely local interest. They do not exactly avoid the Mediterranean region, but they do not favor it either. Except for the lines Villahermosa to Alvaro Obregón and Mexico City to Veracruz, there are not even air connections between important inland cities and ports, such as are so frequently met with in the European Mediterranean region. In aviation Mexico is continentally minded, like many European nations.

It is not necessary to discuss here the airlines in the south of the United States, since they have no direct relation to the theme beyond the fact that they connect the head points of Pan American Airways services and some Gulf ports with the rest of the United States. The Central American republics also can be passed over with a few words. There is a rather well developed internal aviation in Honduras and Nicaragua, of purely local or regional importance. It must be remarked, however, that these small republics feel better than Mexico the necessity of overcoming the transport difficulties of their Atlantic slope by aviation and of bringing these rather outlying regions into direct and rapid communication with the respective capitals. The region of the Panama Canal—the Canal Zone, the adjoining parts of the Republic of Panamá, and the double pair of twin cities of Cristobal and Colón on the Atlantic side and Panamá and Balboa on the Pacific side—has become one of the important centers of commercial aviation in the western hemisphere. The development of Cuban aviation has been favored by bad roads and high railroad tariffs; presumably it will be retarded to a certain extent by the inauguration of the Carretera Central.

Routes in Colombia and Venezuela

The other Central American and West Indian airlines are too insignificant to merit special discussion, but two South American countries must be mentioned. Colombia is the sphere of activity of the Sociedad Colombo–Alemana de Transportes Aéreos (Scadta), a company founded in 1921 with German and Colombian capital. At first it employed German personnel and aircraft exclusively, but today there are also Colombian personnel and American and English planes in its service. The Scadta has played an important part in the history of commercial aviation. Its main line, along the Magdalena River from Barranquilla to Girardot,[10] was the first scheduled air service within the tropics and the first one to use seaplanes; and

[10] This line is still operated, with Bogotá as terminus, but has lost something of its importance by the fact that now the capital is reached sooner by the rapid service with Medellín or San Marcos as only intermediate landing.

together with the British Cairo-Baghdad and the West Australian Geraldton-Derby services it demonstrated for the first time the usefulness of aviation in regions where ground transport is greatly hampered by natural conditions. The Scadta was the first company to be granted a national monopoly in commercial aviation, and in economic discussions it has often been cited as an excellent example of a self-supporting air service without government subsidies. From the first day of its existence it paid the greatest attention to the American Mediterranean, its first and main line connecting the capital[11] with the country's most important port on the shores of this sea. Coastal routes and also a connection between the Atlantic and Pacific regions of the republic were added later. In its projects of international expansion the Scadta was less successful. Lines to Venezuela, the Canal Zone, and Ecuador had to be discontinued.[12] It was the first company to think of an air connection between North and South America, and it investigated the economic, geographical, and technical conditions for such a route in 1922 and 1923, but the American government refused the necessary concessions. When in 1929 Pan American Airways appeared on the scene, a conflict of interests broke out in which, in the long run, the Scadta certainly would have been the loser if an amicable delimitation of the respective spheres of activity and an agreement of coöperation had not been arrived at. But the Scadta lost its monopoly of internal air traffic, to the benefit more of Pan American Airways than of local Colombian companies. It would be unjust, however, to say that Colombia did not profit by the agreement between the two great enterprises, which not only has made her a most important link in the aerial chain between the two Americas but also has orientated her aviation policy toward the American Mediterranean more than the Scadta alone would have been able to do.

Venezuela is not in so advantageous a position, especially since there is no town or city to speak of in the region where the chain of the Antilles meets the continent. She, therefore, had to cede to the British island of Trinidad part of the importance that would have been hers on account of her geographical situation. Although the dictator of Venezuela, General J. V. Gómez, was much interested in aviation, the country for many years had no aviation company of its own; there were only the airlines of Pan American Airways and of a French enterprise affiliated with the Cie. Générale Aéropostale, which operated in the Orinoco basin and at times ran lines to Trinidad and the Venezuelan ports of Chichiriviche and Coro. It was sold to the Venezuelan government when in 1933 France merged her aviation enterprises into the monopoly company of Air-France. Today it

[11] At first the railroad had to be used between Girardot and Bogotá.

[12] Some of the concessions are still in force.

assures a good air communication between the Orinoco region and the coast of the American Mediterranean.

In closing this discussion of the airlines in the American Mediterranean region it must be mentioned that the airway between New York and Santiago occupies a singular place among the aerial highways of the globe: better than any other it coincides with a great circle (in this case practically a meridian, passing through Port-au-Prince, Barranquilla, Iquitos, and Arequipa). In the American Mediterranean region especially the actual airline follows this great circle very closely.

The Aviation Centers

If we finally glance at the knots in the meshwork of airlines in the American Mediterranean, we note a very decided difference from conditions in the other two Mediterraneans. In these there are three centers of first importance, situated, like beads on a thread, on the main traffic axes, both of which run about west-northwest and east-southeast: Marseilles, Rome, and Athens; Bangkok, Singapore, and Batavia. There are striking resemblances in the situations and roles of these six cities if compared pairwise. There is no such axis in the American Mediterranean, and the aviation centers are rather irregularly distributed. One might look for such a center in the region of the Gulf of Darién, where there is not only the door between Central and South America but also the point of intersection of the great circles connecting the east coast of North America with the west coast of South America and the west coast of North America with the east coast of South America. As there is no locality of any importance on the shores of this gulf, one might presume that the role of this theoretical center has been assumed by, and divided between, Barranquilla, Cristobal, and Buenaventura. Here, however, politics have played a part and have made Cristobal a first-class aviation center, whereas Barranquilla, although of great regional importance, can claim only second rank, and Buenaventura not even this, being only an intermediate landing point on the inter-American air routes. Port of Spain is the eastern counterpart of Cristobal, which it cannot rival, however. All other Central American and West Indian aviation centers (Havana, Mexico City and others of minor importance) are of only second rank, points of junction of long-distance with local airlines. In the northern coastal region of the American Mediterranean, Miami is, of course, a center of first magnitude; like Athens and Bangkok, it belongs to that class of cities that, playing a rather insignificant role in ground traffic, are extremely important for the air. The western counterpart of Miami, Brownsville, is no center at all, only an intermediate point. Generally speaking, all the Gulf ports of the United States are more or less in the backwater

of commercial aviation. Take, for example, New Orleans. Its situation resembles that of Marseilles. For land and sea traffic the French port has for hundreds and thousands of years been *la porte de l'Orient*; for aviation it is the door not only to the Orient but also to Africa and, to a certain extent, even to South America. New Orleans has a wider and richer hinterland than Marseilles—the entire Middle West. For ship and rail traffic (railroad ferry to Havana) it is the door to the West Indies and South America—but not for aviation. Its sea horizon is devoid of airlines: not even the coastal line to Havana by way of Tampa, a project of many years' standing, has been realized. Furthermore, New Orleans is not even touched by the airlines from New York or Chicago to Brownsville. In contrast with many other cities, its importance as a traffic center has not been increased by our aerial age. The three most important airline junctions of the southern United States, Atlanta, Fort Worth and Dallas (which can be considered as a unit), and Los Angeles, are too far from the coasts of the American Mediterranean to be included in this region.

It is believed that the foregoing discussion has proved the truth of the thesis advanced in the introduction—that commercial aviation is especially useful and well developed in regions where there is much interpenetration of land and sea, as in the Mediterraneans, and that it has emancipated itself to a very large extent from physical geography, only to be frequently hampered by economic and political geography. But it has also proved true the words written nearly a century ago by a prophetically-minded geographer, J. G. Kohl, the author of the first systematic treatise on the geography of communications:[13]

> Air is anywhere and forms an everywhere continuous and entirely uninterrupted base of traffic, whereas water and land surfaces interpenetrate . . . Without any doubt, therefore, air is the most perfect way of communication and makes possible the noblest and freest method of transport. This element, however, seems to be reserved for future times of greater inventiveness in which human intercourse will reach its highest perfection, its mightiest development, and its greatest freedom.

[13] J. G. Kohl: Der Verkehr und die Ansiedelungen der Menschen in ihrer Abhängigkeit von der Gestaltung der Erdoberfläche, Dresden and Leipzig, 1841, p. 78 et seq.

THE METEOROLOGY OF GREAT FLOODS IN THE EASTERN UNITED STATES*

Charles F. Brooks and Alfred H. Thiessen

DURING January, 1937, a standing high-pressure area in the southwestern North Atlantic sent steamy tropical air into the United States day after day, which, on meeting a persistent flow of polar air in a nearly stationary southwest-northeast belt, precipitated phenomenal rainfalls. Locally exceeding 20 inches, the rains extended across the lower Mississippi and almost simultaneously over the entire Ohio basin. Dammed by the flooded lower Mississippi, the Ohio River became a lake, 15 miles wide in some places, and nearly 10 feet above the highest stages previously known. All the river cities, except Cairo, were partially submerged; one sixth of Cincinnati was under water, one half of Evansville, two thirds or more of Louisville. This flood will probably be best known as the Louisville flood, since the inundation of this populous city drowned several persons and caused an estimated monetary loss of $200,000,000: that the loss of life was not very much greater was owing to the extraordinary service of the local radio station WHAS. In five days this station broadcast 16,500 separate appeals for help. The calls were heard on sound trucks at the shore and on radio-equipped boats that were thus able to effect the removal of at least 58,000 persons from their flooded homes. The January rainfall at Louisville was 19.1 inches, of which 10.14 fell in the five-day period January 20–25. The death toll for the whole flood is, at last reports, 436, the number of refugees 800,000 to 970,000, and the monetary losses from $550,000,000 to well over $600,000,000. The value of some 300,000,000 tons of top soil that the Soil Conservation Service estimates has been carried away from the Ohio watershed is not included. The flood of 1937 must be considered the greatest American flood on record.

This unprecedented flood on the Ohio and lower Mississippi Rivers, coming so soon after the extraordinary floods of March-April, 1936, in the middle and north Atlantic states, compels an examination of the relation of floods to weather in an effort to solve or mitigate their menace. What are the meteorological features of previous great floods, such as those of 1913, 1922, and 1927 in the Mississippi basin? of still earlier general floods, such as those of 1882, 1889, 1903? of the less widespread but remarkable overflows that followed excessive rains in July 1935, November 1927, July 1916, and June 1915? What flood control measures do meteorological considerations most favor? And are flooding rains predictable?

* The assistance of officials of the U. S. Weather Bureau and the American Red Cross in supplying helpful information is gratefully acknowledged.

TABLE I—METEOROLOGY OF CERTAIN GREAT FLOODS*

	Points Worst Affected	River Heights Above Flood Stage (Ft.)				Area Submerged (Sq. Mls.)	Destruction		Maximum Rainfall (Ins.)				Region of Heaviest Rainfall	Rainy Month Departures				Previous Condition of Ground
		Worst Place	Cincinnati (52 Ft.)	Cairo (40 Ft.)	Vicksburg (43 Ft.)		Deaths	Damage In $1,000,000	1 Month	10 Days	5 Days	1 Day		Pressure at Bermuda (In.)	Temperature F° Nashville	Omaha	San Diego	
1882 Jan.	Nashville, Tenn.	13.2	6.6	6.9	....	.....	0?	0.4+	18.1	....	....	5.1	E. Texas to W. Va.	+.09	+3.8	+6.8	-3.9	wet
1889 May–June	Johnstown, Pa.	20c.	....	....	....	.....	9000c.	39	12.5	9.8	9.8	8.4	W. and Central Penn.	-.02	-2.6	+0.1	+0.2	dry
1903 May	Kansas City, Mo.	14	1.2	5.6	6.8	6,820	100	40+	18.5	9.7	6.3	3.7	Okla. to S. Minn.	-.04	+0.6	+0.5	-0.1	wet
1913 Mar.	Dayton, O.	10.1	17.9	9.7	7.3	.....	732	113	13.1	11.8	11.2	7.0	S. Cent. Ind. and Cent. O.	+.30	-1.2	-2.1	-1.4	wet
1915 June–July	Kansas City, Mo.	7	....	....	....	.....	0	10.5+	14.9	8.2	7.0	5.8	Lower Mo. basin	-.06	-1.9	-4.0	+1.0	wet
1916 July	W. North Carolina	22.5	....	....	....	.....	20	22	37.4	31.1	24.4	22.2	Appalachians and SE.	+.01	-0.7	+6.2	-2.2	wet
1922 Mar.–May	St. Louis, Indianapolis	4 10c.	0.2	8.6	10.0	13,200	0	17	17.6	11.5	11.3	9.3	Lower Miss. basin	+.14	+1.3	+3.5	-1.9	wet
1926 Dec.–	Nashville,												E. Texas to W.					
1927 Jan.	Tenn.	14.8	7.1	3.9	1.5	.....	3	3	19.4	14.8	13.1	6.3	Va.	+.01	-0.1	-1.3	-0.8	wet
1927 Apr.–May	SE. Ark. and S. Cent. La.	13.7	7.1	11.4	13.7	6880	219	284	23.8	18.6	18.5	18.5	Arkansas	+.06	+3.4	+1.1	-0.2	wet
1927 Nov.	Winooski Valley Vt.	10c.	....	....	....	.....	88	40	14.5	9.9	9.7	9.4	New England	+.14	+4.4	+0.1	+3.6	wet
1935 July	S. half of West N.Y.	7.5	....	....	....	.....	52	26	19.4	14.6	11.7	9.0	Western and Cent. N. Y.	+.17	+1.0	+7.0	+0.6	dry
1936 Mar.–Apr.	W. Pa. and S. New Eng.	21	8.6	12.8	....	.....	470	500c.	10.0	8.0	7.4	4.5	C. Appalachians and New Eng.	+.15	+4.6	+5.4	+0.7	wet
1937 Jan.–Feb.	Louisville, Ky.	29.1	28.0	19.6	10.2	.....	436	550c.	23.9	20.2	12.3	6.5	Ark. to S. Ohio	+.36	+3.6	-12.6	-4.0	wet
									23.1	17.1	11.2	4.4						

*Compiled from *Monthly Weather Review*, *Monthly Weather Review Supplements* 22 and 29, *World Weather Records*, and miscellaneous sources.

Causes of the Great Floods

Two elements are always involved in the production of a great flood in the eastern United States: a rapid and continuing flow of moist tropical air into the country and a frequent or persistent elevation of this tropical current by a colder air mass over the same region.

Such a wind situation depends on a persistent high-pressure area in the western Atlantic and another high over the central or northern interior of the United States or farther west. The Atlantic high pushes air from the tropical Atlantic northwestward, northward, or northeastward, while the western high pushes the polar air southeastward, southward, or southwestward. The low pressure trough between the highs is marked by one or more moving centers. Its position varies in accordance with the relative strengths and locations of the two highs from day to day. The western high or an offshoot from it often moves eastward; thence it may pass out to sea, to strengthen the Atlantic high and, consequently, the landward flow of tropical air. This is what happened January 20 to 25, 1937. Along the front between the polar and the tropical air masses continuous, sometimes violent, ascent of the warmer current is in progress. Either the tropical air is the aggressor (warm front) or the polar air is making gains (cold front). In either event, the tropical air is forced upward, though usually with less violence on the warm front than on the cold. This is why it rains.

When moist tropical air is forced to rise, it expands in the lower pressure aloft and cools at such a rate that in an ascent of two miles three quarters of its vapor will be precipitated. If such air, originally nearly saturated at 77° F. (25° C.) over the Caribbean Sea, has been chilled over land in middle latitudes to 68° F. (20° C.), a layer of such air two miles (3.2 km.) thick would contain about 80,000 tons of water vapor over each square mile of surface. If it were forced upward over a cold air mass or by convergence to a height of two miles, some 60,000 tons of its vapor would be precipitated, or the equivalent of 0.8 inches (2 cm.) of rain. Since the slope of the upper surface of the cold air mass is commonly only one or two per cent, the elevation of the tropical air mass by two miles would require the passage of 100 or 200 miles of wind, which at a velocity of only four to eight miles an hour would complete the entire elevation in one day. Since the advance of a tropical air mass commonly proceeds at 30 to 40 miles an hour, it is easy to see how rains of several inches in one day may fall when a tropical air mass mounts a polar one. The heaviest fall occurs when the polar front is standing or advancing under the tropical air mass.

The weather preceding any flood is important in its conditioning of the watershed as regards runoff. If the weather has been rainy before the heavy continuous rains that make the flood and the ground has become soaked, runoff naturally is favored. With well frozen ground a like condition exists.

*Compiled from Monthly Weather Review, Monthly Weather Review Supplements 22 and 39, World Weather Records, and miscellaneous sources.

The runoff that produces great floods of the Mississippi is between 25 and 30 per cent of the rainfall over the entire drainage area, which, however, includes semiarid lands.[1] In Tennessee the average runoff is estimated as 45 per cent.[2]

The current weather conditions tending to make floods are continuously heavy rains and temperatures above freezing. Freezing during the night is a flood deterrent. Warm rains and high temperatures with strong winds melt the layer of snow if there is any; and rain and snow water run off together. An old snow cover is so dense, however, that much more time is required to remove it than freshly fallen snow, the more so if it lies in the shelter of a forest. Ten inches of rainfall in a day or two will produce a flood anywhere and at any time in the eastern United States. Five inches will suffice if the ground is bare or lightly snow-covered and already saturated or frozen. Under such conditions 60 to 100 per cent of the water may run off into the streams. The Muskingum River (Ohio) flood-control plan is based on a hypothetical ten inches of rain in five days on frozen ground with a 90 per cent runoff.

On the other hand, dense vegetation and a dry soil or a deep snow cover on unfrozen ground may wholly absorb five or more inches of rainfall. Thus in March, 1936, in experimental plots in the upper Susquehanna drainage, while 60 per cent of a five-inch rainfall over several days ran off of open cultivated fields that were frozen, none came from the unfrozen forest near by; and at the Arnot Soil Conservation Experiment Station in Schuyler County, New York, while a runoff of 7.9 inches, including melted snow, came from frozen, open fields after 6.4 inches of rainfall, March 10–19, 1936, only 0.1 inch came from a beech-maple forest plot, where 12 inches of snow remained unmelted after the snow had disappeared in the open.[3] Of the 27 inches of rainfall causing the great flood of the Yazoo River, Mississippi, in 1931–1932, 62 per cent ran off from cultivated fields, 54 per cent from abandoned fields, 2 per cent from scrub oak, and 0.5 per cent from undisturbed oak forest.[4] The Soil Conservation Service reported that 8 inches or 95 per cent ran off of plowed land in Ohio in the heavy rains of January, 1937, but only 2 inches from comparable areas under grass and trees.

Seasons of Great Floods

It is no accident that great floods occur only in winter or spring, even though the melting of accumulated snow is usually a minor or

[1] H. C. Frankenfield and others: The Spring Floods of 1922, *Monthly Weather Rev., Suppl. No. 22*, 1922, pp. 7–8; *idem;* The Floods of 1927 in the Mississippi Basin, *ibid., Suppl. No. 29*, 1927, p. 31.

[2] Forests in Flood Control, *Supplemental Rept. to the Committee on Flood Control, House of Repr., 74th Congr., 2nd Sess.*, on H. R. 12517, Washington, 1936, p. 4.

[3] *Ibid.*, p. 6.

[4] *Ibid.*, pp. 3 and 51–59.

negligible factor. Summer and autumn rains in the eastern United States may be as great as those of winter and spring and are usually more intense, that is the rate of fall is more rapid. There is so much more vapor in the air that strong general storms are not required for the production of excessive rains, and when a hurricane puts the vapor through the cyclonic wringer at high speed the rains exceed any that can be produced in winter. Fortunately, however, there is in the active vegetation of the warm season an effective intercepter of rain, a mechanical hindrance to runoff, and a rapid user of ground water. Hardwoods in Wisconsin when in leaf intercepted 25 per cent of the rainfall but only 16 per cent when dormant;[5] but this difference of 9 per cent of the rainfall is but a small part of the total change in runoff from summer to winter for the same rainfalls. Besides the several effects of vegetation, evaporation from the ground is greater in summer. A comparison of runoff with rainfall at Knoxville, Tenn.,[6] shows an average runoff for 1900–1923 of only 28 per cent in summer and 30 per cent in autumn, whereas in the three months January to March it was 64 per cent. Even in summer months with 7 to 12.5 inches of rainfall the runoff was only 25 to 37 per cent. The runoff of 4.06 inches from the 10.89 inches of rainfall in the hurricane flood of July, 1916, and that of 4.38 inches from the 12.52 inches of rainfall in August, 1901, did not equal the 4.22 and 4.54-inch runoffs from the 7.00 and 7.10-inch rainfalls of the March floods of 1922 and 1913. To produce important floods in summer, monthly rains well in excess of 10 inches are required, whereas half as much will suffice in winter. Summer rains, in general, are spottier than winter ones; and excessive downpours are more restricted in area than ordinary heavy rains. So summer floods are usually more local and of shorter duration than winter ones. In the cold season the low evaporation permits the ground to stay wet for a long time after a rain, and a freezing of the ground may stop percolation. Before the rivers have carried away the water from one general rainstorm another may occur and add to the burden.

The Ohio-Mississippi Flood of January-February, 1937

These general observations may now be examined in the specific terms of the Ohio-Mississippi flood of January-February, 1937. In the eastern United States northwesterly or northerly winds normally prevail in winter, pushed from the high pressure formed by air accumulated over the cold continent toward the low pressure over the warm waters of the Gulf Stream and beyond. Occasionally, however, the semipermanent high-pressure area of the subtropical Atlantic, which

[5] *Ibid.*, p. 4. Cf. also H. I. Baldwin and C. F. Brooks: Forests and Floods in New Hampshire, *New England Regional Planning Commission, Publ. No. 47*, Boston, 1936, pp. 5-9.

[6] J. F. Voorhees: A Preliminary Study of Effective Rainfall, *Monthly Weather Rev.*, Vol. 53, 1925, pp. 63-65.

is usually some distance east of North America, expands and builds up westward into the Bermuda region. This happened in December, 1936, starting, after a cold November, a most remarkably mild and wet winter for the eastern part of the country. Bermuda pressures were only moderately high in the first three weeks of December, but from the 22nd of that month until the 29th of January the morning pressures did not fall below 30.20 inches. The mean for January was 30.32 inches, in place of the 29.96-inch normal. Pressures must have been higher farther east, for the wind at Bermuda was prevailingly southeast to south.

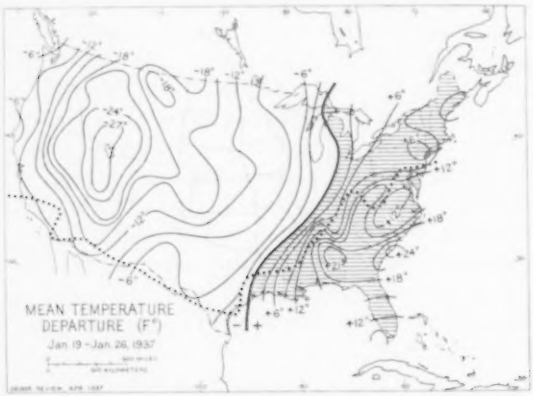


FIG. 1—The departure of mean temperatures from the normal for the week ending 7.30 a. m., January 26, 1937. (From *Weekly Weather and Crop Bull.*, Jan. 26, 1937.) The shaded area shows excess temperature (F.°); the unshaded area, deficiency; the dotted line, the southern limit of freezing weather.

Why the high formed and stayed in the southwestern North Atlantic is unknown. Sea temperatures may have been lower than usual here and higher than is common farther east and such distribution may well play an important part,[7] though it hardly seems possible that even the greatest sea-temperature departures could account for all of the large pressure anomaly. In accordance with the pressure gradients on the south and west of this standing Bermuda high, great tropical air masses moved day after day over the hot waters of low latitudes westward and northwestward toward the United States. Passing the length of the Caribbean Sea they turned northward into the Gulf of Mexico and entered the continent nearly saturated with water vapor to a height of two kilometers or more. Flooding rains were inevitable. The question was, where? The Arctic held the answer.

The major interzonal exchanges of air take place in alternating bands of considerable width. In January, 1937, there was a northward current of tropical air occupying a band about 2000 miles wide from somewhere east of Bermuda to a short distance west of the Mississippi River. Its western boundary is strikingly suggested by the sharp gradient between the large positive temperature departures east of

[7] Cf. W. J. Humphreys: Why Some Winters are Warm and Others Cold in the Eastern United States. *Monthly Weather Rev.*, Vol. 42, 1914, pp. 672–675. For a case the reverse of 1937 conditions see C. F. Brooks: The "Old-Fashioned" Winter of 1917–18. *Geogr. Rev.*, Vol. 5, 1918, pp. 495–414.

the Mississippi and the large negative ones to the west (Fig. 1). From the plains to the Pacific coast and beyond a southward current of polar air prevailed occupying a band also about 2000 miles wide.

The chilling and shrinkage of air continuously in progress in the polar regions in winter leads to an accumulation of air that must discharge toward the lightened pressures of middle latitudes. The loci of chief upbuilding of polar air masses vary somewhat from year to year, apparently in relation both to the distribution of cold surfaces, namely ice-covered sea and snow-covered land, and to the proximity of warm surfaces, for the expanded air over warm surfaces readily overflows and feeds the accumulating cold air masses.

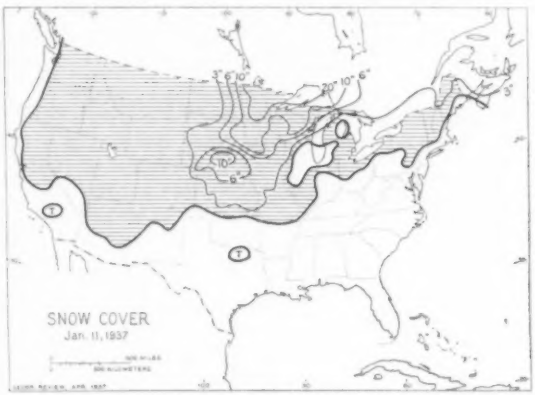
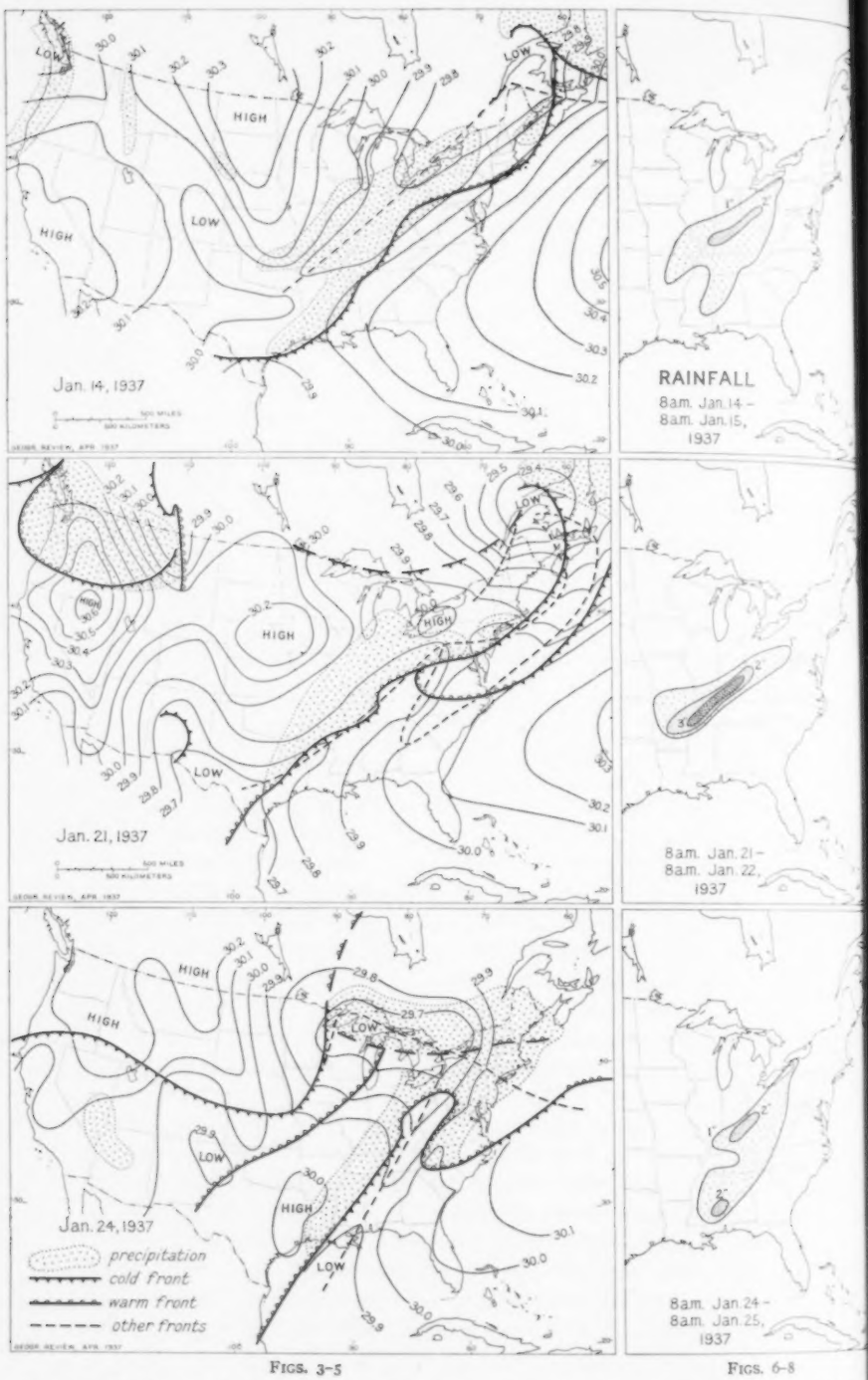


FIG. 2—The depth of snow on the ground, 8 p. m., January 11, 1937. (From *Weekly Weather and Crop Bull.*, Jan. 12, 1937.)

Furthermore, the channels through which the discharges take place tend to be maintained for weeks or months. This seems partly to be owing to the locations of the accumulation areas but is also the result of conditions favoring the transport of cold air without too much warming en route. The first outbreaks of polar air lay down a carpet of snow, which thereafter neither becomes warm itself nor permits much heat from the ground to reach the top of the snow blanket; portions of the polar air masses continuing over the snow are less warmed than if they passed over bare ground; pressure over the snow-covered regions continues high; and further progress of the cold mass is facilitated.

The Arctic outpourings in the winter of 1936–1937 established a favoring lane southward through the western half of North America and, with few interruptions, dominated this region, continuing drought on the Great Plains, elevating Pacific air to lay down deep snows in the far West, and freezing the oranges of southern California.

A heavy snow cover became established in the upper Mississippi Valley and upper Lakes region, where the eastern margin of the polar air mass frequently elevated the much-chilled western margin of the tropical air mass. This snow-covered region, like that over the western plateau became a secondary booster of polar air masses, strengthening them for combat along the tropical front to the southeast.



FIGS. 3–5 FIGS. 6–8

FIGS. 3–5—Weather maps for 8 p. m., January 14, January 21, and January 24. 1937, respectively. (Isobars and dashed lines courtesy U. S. Weather Bureau; precipitation, cold and warm fronts courtesy Massachusetts Institute of Technology

FIGS. 6–8—Rainfall in excess of 1 inch in the 24 hours ending at 8 a. m., 75th Meridian Time, on January 15, January 22, and January 25, 1937, respectively.

The weather maps for January 14, 21, and 24, when the heaviest rains were in progress, show the principal fronts and trough of low pressure between the Bermuda and northern highs (Figs. 3–5). The weather map of January 14 (Fig. 3) indicates in typical form the Atlantic high and another high over the eastern slope of the Rockies. A cold front extends in a general northeast-southwest direction and

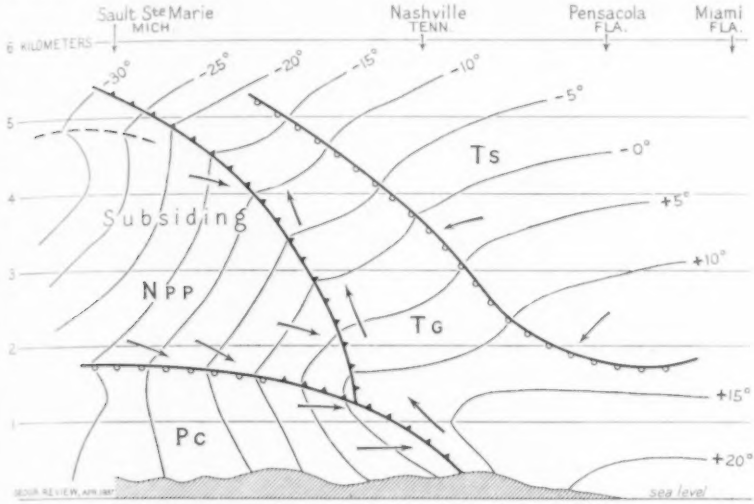


FIG. 9—Cross-section of air masses and fronts, north to south, at 8 a. m., January 22, 1937. (Courtesy Massachusetts Institute of Technology.) Warm and cold fronts shown by conventional symbols; NPP, modified Polar Pacific air; Pc, Polar continental air; TG, Tropical Gulf air; Ts, Tropical superior air.

lies just west of the Appalachians. It stalled in that position or moved very slowly from the morning of the 14th to the evening of the 15th. West of the frontal line was polar Pacific air, and east was tropical air. Heavy rains fell in a narrow belt extending from Lake Erie in a southwesterly direction to Arkansas.

The succession of formations from January 14 to 25 presents most interesting examples of frontal interactions, as indicated in some measure by the successive daily positions of the tropical front, shown in Figure 10. Table II shows the daily rainfalls at selected stations, as published on the Washington weather maps.

Although heavy rains occurred early in the month, it was not until the 14th that excessive precipitation fell over the Ohio basin. This precipitation came in advance of a slowly moving cold front, which by the 15th had pushed eastward to the crest of the Appalachians and so completed a considerable lifting of a large body of moist tropical air. A day of fair weather with northwest to north winds ensued (see Table II); but by the 17th the tropical wind had again established itself over the region. Another cold front soon lifted this tropical

wind and squeezed it against the Appalachians again, producing heavy rain on the 17th and 18th, followed by northwest winds and fair weather for a day. Owing apparently to the major thrust of polar air into low latitudes along the eastern seaboard of the United States, a large return of tropical air on the 20th brought renewed heavy precipitation, which continued in the form of instability showers, even

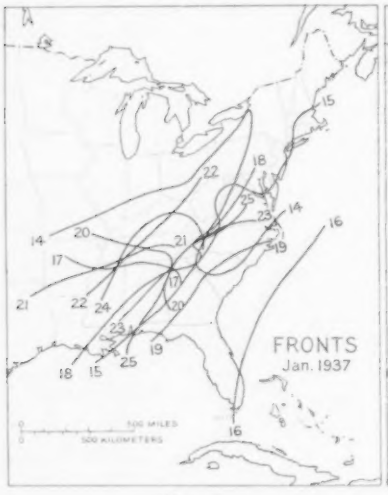


FIG. 10

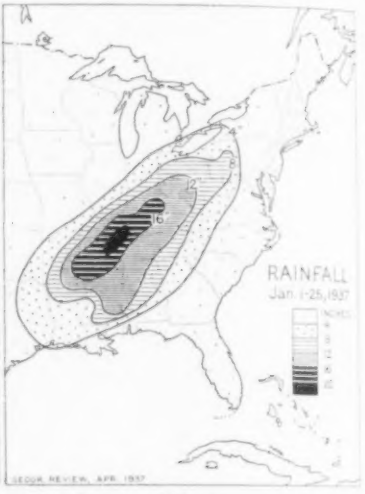


FIG. 11

FIG. 10—Successive daily positions (8 a. m.) of the front between tropical and polar air masses from January 14 to 25, 1937. (Determined from wind, temperature, and weather contrasts shown on the Washington daily weather maps.)

FIG. 11—Rainfall in the Ohio and Lower Mississippi basins between January 1 and 25, 1937. (Courtesy U. S. Weather Bureau.)

thunderstorm rains, until the 24th. (Fig. 9 is a north-south cross-section of the air masses, Jan. 22.) The rainfall in this five-day period was of the order of 10 inches in a narrow central belt from Louisville to Little Rock. The day of greatest rainfall in the Ohio Valley was the 21st (see Fig. 7). The winds at the surface were mostly northerly during these heavy rains: the tropical front was to the south. The temperatures of this remarkable week are shown in Figure 1. The rainfall for January 1–25, half to two thirds of which fell in the five days January 20–25, is shown in Figure 11. J. B. Kincer computed that in the belt of heaviest rainfall about 100 miles wide and 550 miles long the 16 inches of rainfall amounted to more than 60 billion tons of water.[8] This precipitation was four times the normal amount.

Table III shows the flood stages produced throughout the length of the Ohio River, which, except at Pittsburgh, reached the highest

[8] Record-breaking January drought, floods, freezes, and early blooms. *Information for the Press*, U. S. Dept. of Agriculture. Jan. 30, 1937.

TABLE II—WIND DIRECTIONS AND DAILY RAINFALLS IN THE OHIO AND LOWER MISSISSIPPI VALLEYS, JANUARY, 1937

(In inches, during 24 hours ending at 8 a. m. 75th Meridian Time)

DAY	LITTLE ROCK, ARK.	MERIDIAN MISS.	MEMPHIS TENN.	NASHVILLE TENN.	CAIRO ILL.	EVANSVILLE IND.	LOUISVILLE KY.	CINCINNATI OHIO
14	S .04	S .01	S 0	S .01	S .50	SW .70	S .28	SW .58
15	N 1.00	W 1.50	NW .86	NW 1.02	NW 1.46	NW 2.52	W 2.52	NW 2.08
16	E 0	NE 0	E 0	NE 0	N 0	NE 0	E 0	NW 0
17	S .14	S .10	E .30	SE .54	S .14	S .12	SE .38	S .02
18	NW 2.00	.....	NW 2.39	W 2.28	N 1.54	NW 1.70	NW 1.54	SW 1.78
19	E 0	E 2.08	NE 0	NE .28	NE 0	NE 0	NE 0	NE 0.01
20	S .14	S 2.24	S 1.56	E 2.32	SE .12	E .40	SE .14	SE .04
21	E 4.36	S .02	E 1.52	NE .48	N 2.92	N 2.78	E 2.48	W 1.98
22	N 2.32	S 0	N 3.24	NE .72	N 2.06	N 1.52	N 3.34	N 2.00
23	NE 1.26	NW .02	N .78	N 1.86	N 1.36	N .80	N 1.22	NE .66
24	N .01	SE 1.24	E 2.08	SE .18	E .52	NE .46	NE .44	NE .16
25	N .84	N 2.32	N .96	NW .46	SW .90	W 1.36	NW 2.66	W 2.38
14-25	N 12.11	S > 9.53	E 13.69	NE 10.15	N 11.52	N 12.36	Var. 15.00	NE 11.69

stages ever known. One of the meteorological hazards in a great flood, when the waters are lapping the tops of the levees at the edge of a moving lake miles wide, is the wind. Not only does the wind raise erosive waves, but it also raises the stage of the water. Thus at Memphis after an apparent crest had been reached, a 25-mile wind raised the level by 0.1 foot.

When so enormous a quantity of water is involved, spread out over the lowlands, the passage of even great masses downstream lowers the upstream stages but slowly. The quantity of water represented by one foot when the flood is at its height is equal to that represented

TABLE III—MAXIMUM FLOOD STAGES, OHIO AND LOWER MISSISSIPPI, JANUARY AND FEBRUARY*

STATION	FLOOD STAGE *feet*	DURATION ABOVE FLOOD STAGE, 1937	CREST, 1937 STAGE	CREST, 1937 DATE	PREVIOUS RECORD STAGE	PREVIOUS RECORD DATE
Pittsburgh	25	Jan. 19–19	28.0	Jan. 19	46.0	March 18, 1936
		Jan. 21–27	34.5	Jan. 26		
Portsmouth	50	Jan. 18–Feb. 4	74.1	Jan. 27	67.9	March 31, 1913
Cincinnati	52	Jan. 18–Feb. 4	80.0	Jan. 26	71.1	Feb. 14, 1884
Louisville	28	Jan. 16–Feb. 7	57.1	Jan. 27	46.7	Feb. 16, 1884
Evansville	35	Jan. 10–Feb. 19	53.7	Jan. 31	48.4	Apr. 5, 1913
Nashville	40	Jan. 3–10	45.3	Jan. 8		
		Jan. 19–Feb. 4	53.8	Jan. 26	56.2	Jan. 1, 1927
Cairo	40	Jan. 10–Feb. 27	59.6	Feb. 3	56.4	Apr. 20, 1927
Memphis	34	Jan. 20–†	48.65	Feb. 9–10	45.0	Apr. 9, 1913
			50.3§	Feb. 9–10	46.6§	Apr. 9, 1913
Vicksburg	43	Jan. 30–†	53.2	Feb. 21	58.6	May 4, 1927
New Orleans	17	Feb. 7–†	19.1	Feb. 26–March 1	21.3	Apr. 25, 1922

*Data from U. S. Weather Bureau gauge records.
†Still above flood stage on March 1, 1937. §Beale Street gauge.

by several feet at lower stages. So great was the discharge of the Ohio relative to the Mississippi at the junction of the rivers that in this 1937 flood the flow of the Mississippi above the mouth of the Ohio was reversed. This means that all the runoff of the Mississippi above Cairo was stopped for a time and that even moderate rains plus the water from the melting of the great quantity of snow in the upper Mississippi and middle Missouri Valleys might have raised the levels of these rivers above flood stages before the flood waters of the Ohio passed on. Frankenfield found the damming effect of a flooded Ohio nearly to St. Louis. Similarly the great discharge of the Arkansas and other streams into the Mississippi below Cairo created a water dam. It is obvious why the period of high waters in the lower Mississippi is protracted.

Western Cold the Accompaniment of Eastern Floods

The flood so eclipsed all else in weather news that the extreme cold in the West received little general attention. Throughout January polar air masses were just as persistently covering the West as tropical ones were deluging the East. Oranges were freezing in southern California while they were ripening too fast in Florida and early fruit trees were blossoming in southern South Carolina. Figure 1 shows temperatures more than 20° F. below normal in the central and southern plateau region, where a blanket of snow maintained the original polar frigidity of the air. As thrust after thrust of polar air pushed southward in floods deep enough to overtop the usually protecting mountain wall of southern California—as indeed the floods of waters had overtopped the protecting walls along the great rivers in the East—this famous subtropical corner of the United States experienced a month of frequent freezes, ice, and occasional snow and was often colder than southern New England. The mean temperature of January at Los Angeles was 1.3° F. lower than the coldest on record. Two pronounced periods of cold, January 7–10 and 20–24, the latter coinciding with the rainiest period in the Ohio Valley, destroyed about half the orange crop, despite frantic efforts to heat the orchards. Farther north, real wintry weather prevailed over the coastal belt as well as to the east. At the end of January Portland was buried in its heaviest snowstorm of record.

Is western cold the normal accompaniment of eastern floods? In Table II are shown temperature departures of months when flooding rains were producing great floods in the east. Subnormal temperatures in San Diego have been coincident with the chief rainy months of all other general floods of winter or early spring in the Ohio and lower Mississippi valleys since 1882: the years 1883, 1897, 1903, 1907, 1912, 1916, 1920 and 1926 (Dec.). Obviously widespread and great flooding

FIG. 12

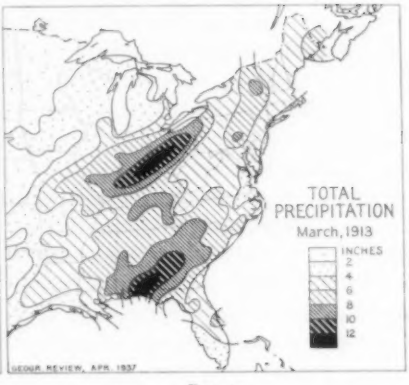


FIG. 13

FIG. 12—Rainfall, March 23 to 27, 1913 (after F. J. Walz, *Monthly Weather Rev.*, March, 1913; map opposite p. 368).
FIG. 13—Total precipitation in the eastern United States, March, 1913.

rains in the Ohio and lower Mississippi valleys are attended by cold weather in southern California owing to a natural opposition between the great interlatitude currents of air.

SIMILARITIES BETWEEN THE OHIO FLOODS OF 1913 AND 1937

The conditions causing the excessive rainfall of up to 14 inches in northern Tennessee and 17 inches in northeastern Arkansas in January, 1913, and from 13 inches in southwestern Indiana to 12.7 in north-central Ohio in March, 1913, were almost identical with those of January, 1937. The pressure at Bermuda was 0.19 inch above normal in January, 1913, and 0.30 above normal in March; which are to be compared with 0.36 above normal in January, 1937.

The rainfall, though not so great over the Ohio and lower Mississippi watersheds as in the flood of 1937, nevertheless produced exceptional floods in the Ohio basin. In January, 1913, a number of low pressure troughs parallel to

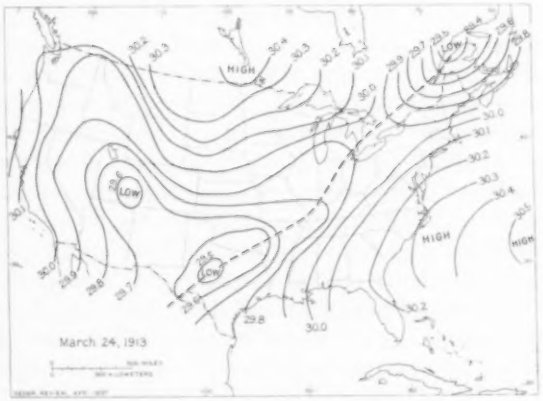


FIG. 14—Weather map of 8 p. m., March 24, 1913. (Courtesy U. S. Weather Bureau.)

the Ohio in regular succession were accompanied by heavy rains south of the river in the first half of the month and north of it in the last half. A crest of 62.2 feet was reached at Cincinnati on the 15th. Before the flooding rains the ground was neither snow-covered nor frozen.[9]

The second flood, which after rising 43.5 feet in five days, culminated at 69.8 feet on April 1 at Cincinnati, was due to the tremendous rains of March 23–27,[10] when more than 10 inches fell at four stations (Fig. 12). The occurrence of three tornadoes in southern Indiana, southern Illinois, and Kentucky on the evenings of March 23 and 24 and the morning of the 25th were further evidence of an extraordinary intensity of convection of the tropical air. The sudden rise of the Miami, at Dayton, 17 feet in one day, was mainly responsible for the large loss of life, totaling 732 persons.

Between the great high at Bermuda, which was driving the tropical air, and the strong northern continental high, which was pushing the polar air kept well chilled by the deep snow cover of the region about and westward of Lake Superior, much as in 1937, the trough of low pressure moved only slowly for several days (Fig. 14). The fronts of 1913 were farther north than those of 1937, and the belt of excessive rainfall in March, 1913 (Fig. 13) was about 100 miles to the north and somewhat to the east of that of 1937 (Fig. 11); and no excessive rains fell across the lower Mississippi in March, 1913. The line dividing plus and minus temperature departures was farther east in 1913 (85th meridian) than in 1937 (Fig. 1).

Comparison with Floods of 1922 and 1882

In March, 1922, a well developed high in the southwestern Atlantic, averaging 0.14 inch above normal for the month at Bermuda, sent a copious flow of tropical marine air into the United States. Encounter with polar air masses took place over a broad area of the interior. Precipitation was so widespread that, with the exception of the Tennessee and Cumberland Rivers, the Mississippi and all its tributaries were in flood at the same time. The rainfall contributing to this flood as a whole, counting all the precipitation from January to April inclusive over the entire 1,250,900 square miles of the Mississippi drainage basin, averaged 10.58 inches, 33 per cent of which came in March and 36 per cent in April. The runoff was 25 per cent. Regionally the March rainfall ranged from 13 inches in eastern Arkansas to 11 in central Kentucky and up to 15 in Louisiana and 14 in southern Mississippi. The rain fell mostly on March 10, 14 to 15, and 30 to 31, when the tropical front passed through these regions, while the supply

[9] A. J. Henry: Rivers and Floods, January, 1913, *Monthly Weather Rev.*, Vol. 41A, 1913, pp. 148–149.

[10] *Idem:* Rivers and Floods, March, 1913, *ibid.*, pp. 485–492.

of tropical air was maintained by the Bermuda high, which was particularly strong in these three periods. Daily rainfalls were commonly 1.5 to 3 and nearly 4 inches. April's excessive rainfall was mostly 12 inches in southeastern Kansas to 9 inches in central Indiana.[11]

In January, 1882, there was a southwest-northeast band of excessive rainfall extraordinarily like that of January, 1937 (Fig. 11), with rainfalls of 8 to 10 inches in eastern Texas up to over 15 inches in eastern Tennessee; but this band lay about 100 miles south of that of 1937. In February, 1882, 8 to 10 inches of rain fell over Arkansas and more than 8 inches over the lower Ohio basin. The Cumberland River at Nashville rose to 54 feet 7 inches, just topping the great flood of 1847. The flood was due chiefly to the excessive rains, locally 3 inches a day on January 12 to 13, 16, 21, and 27 to 28. Bermuda pressures were 0.09 inch above normal in January and 0.08 above normal in February, and temperatures were generally above normal throughout the eastern and central United States. North of the flood belt and in the Northeast there were heavy snows.

The West, as usual when the central valleys are flooded, was cold. Southern California experienced the severest freeze and heaviest snowstorms ever known. On January 13 snow fell generally, even at San Diego, and at Riverside it was deep enough (5 inches) for sleighing among the orange groves. Frost occurred on 29 days of January in southern California and on 20 days of February.

Another visitation, almost identical with that of January, 1882, came in December, 1926, when, after wet preliminaries, a total of nearly 10 inches of rain fell over the Cumberland Valley in 9 days and the river at Nashville reached 56.2 feet.

April and May Floods in the Mississippi Valley

Middle and late spring floods, though caused in much the same manner as the winter floods already discussed, have the advantage of more vapor in the warmer tropical air and a greater intensity of convection and therefore of local storminess. The leafing out in spring, however, with increased interception and transpiration, reduces the runoff. Three floods may be cited: the general flood of April–May, 1927, a very great one, and the Missouri Valley floods of May, 1903, and June, 1915.

In April, 1927, as in early 1937, 1913, and 1882, a standing high in the southwestern Atlantic (Bermuda +0.06 inch) drove tropical air over a long fetch of very warm water[12] and into the south-central United States, where it met large flows of polar air in the middle and lower Mississippi basin. The severe rainstorms—12 to 24 inches of

[11] Frankenfield, The Spring Floods of 1922, *loc. cit.*

[12] Note the southeast-northwest isobars across the Caribbean on the North Atlantic weather maps, *Monthly Weather Rev.*, Vol. 55, No. 4, 1927, Charts 8–11.

rain fell in April over eastern Oklahoma, central and northern Arkansas, southern Missouri, and western Tennessee, while a large area around had more than 8 inches—following only two months after a midwinter flood, produced the highest stages theretofore known in the Arkansas and lower Mississippi Rivers. Frankenfield computed that about 55 cubic miles of water went down the Mississippi (26 per cent of the 213 cubic miles of precipitation January to April).[13] Melted snow made a negligible contribution, as in 1937, 1922, and 1913.

The rains in April, 1927, were of greater violence than in 1937, being associated frequently with thunderstorms and occasional tornadoes. In five days, April 10–14, eighteen tornadoes occurred in connection with the mixing of very cold polar air with fresh tropical air in Texas, Oklahoma, and Arkansas. Here again, as in 1937, 1913, and 1882, the coldness of the polar air was preserved by the deep snows not far to the north. The snowfall in April, 1927, was tremendous on the northern Great Plains, as much as 60 inches south of the Black Hills. The cold front frequently stalled in the Ouachita or in the Ozark Mountains, as if the slight obstruction here was responsible for holding the slowly moving front. A quasi-stationary cold front here on April 19–21 yielded 5 to 12 inches of rainfall. Another period of nearly continuous rainfall was April 7–16. Analysis of the immediate cause of the rainfall showed that convergence in south winds was answerable for 43 per cent, ascent over a warm front with northeast winds at the surface for 35 per cent, and ascent over a cold front with northwest winds at the surface for 22 per cent.[14]

The floods of May, 1903, and of June, 1915, in the lower Missouri, affecting Kansas City chiefly, were due to the northward thrust of tropical air by a high in the southeastern states and a westward or southwestward thrust of polar air from standing highs in the Lake region and westward. Lows stalled over the central plains and yielded tremendous quantities of rainfall in the form of great showers.[15]

Floods Caused in Part by Orographic Rainfall: Appalachian and Northeastern Floods of March, 1936

In the floods of March, 1936, the Appalachian barrier seemed to play an important role by forming the divide between banked-up polar air on the west and tropical or underlying modified polar Pacific

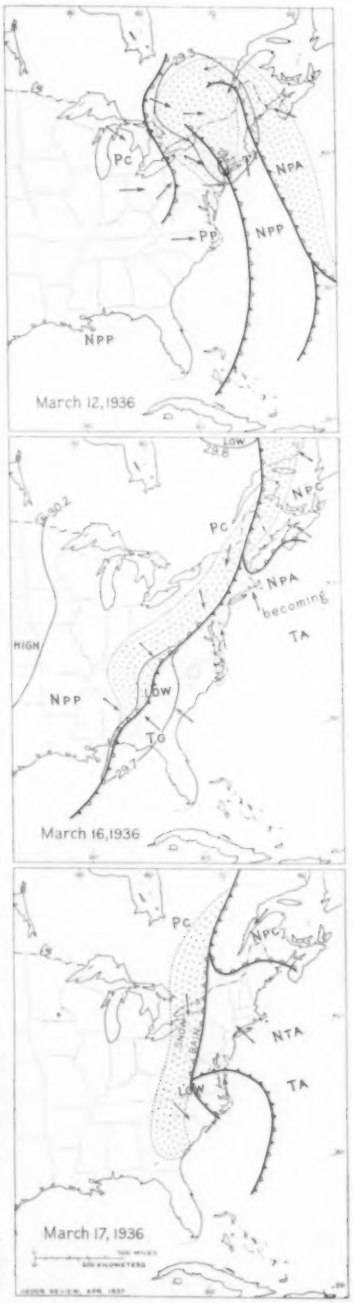
[13] Frankenfield, The Floods of 1927, *loc. cit.*: for a summary see A. J. Henry: Frankenfield on the 1927 Floods in the Mississippi Valley, *Monthly Weather Rev.*, Vol. 55, 1927, pp. 437–452.

[14] C. F. Brooks [and N. H. Bangs]: [The Causes of the Flooding Rains of April, 1927] in discussion of "Flood Control with Special Reference to the Mississippi River," *Proc. Amer. Soc. of Civil Engineers*, Vol. 54, 1928, Part 1, pp. 1260–1265.

[15] H. C. Frankenfield: Floods of the Spring of 1903 in the Mississippi Watershed, *U. S. Weather Bur. Bull. M*, 1904; P. C. Day: The Weather of the Month [May, 1915], *Monthly Weather Rev.*, Vol. 43, 1915, pp. 250–252; A. J. Henry: The Floods of May and June, 1915, in the Missouri Valley, *ibid.*, pp. 286–287; P. Connor: Loss by Floods in Kansas River and Tributaries, June, 1915, *ibid.*, pp. 287–88; A. J. Henry: Rivers and Floods, July, 1915, *ibid.*, pp. 353–355.

or polar continental air masses on the east. While this favored fairly continuous rain, glaze, sleet, and snow in successive belts westward from the divide, heavy rains fell on the east of the divide as fronts nosed northeastward under the strong tropical wind from the southeast.[16] Extraordinary rains fell where the action of these fronts was augmented by such pronounced obstructions as the White Mountains. Thus at Pinkham Notch, at 2000 feet on the southeast slope of Mt. Washington, N. H., which rises 4300 feet above it, 6.46 inches of rain fell on March 12, while the wind on Mt. Washington reached a velocity of 158 miles an hour from the south-southeast. On the 18th 6.27 inches of rain fell and 4.05 more on the 19th, while the winds on the mountain reached 132 miles an hour from the southeast. The total rainfall at Pinkham Notch in the 14 days from March 9 to 22 was 22.43 inches; at Randolph, north of the mountain, 16.19; and on the summit of Mt. Washington, 13.86.

The Atlantic high on this occasion was centered off the middle and north Atlantic states instead of Bermuda and southward as in the other three great floods. Nevertheless, the pressure at Bermuda in March, 1936, averaged 0.15 inch above normal. Thus the tropical air streams reached the United States from the southeast and mostly along the coast north of Hatteras. The speed of inflow in the



[16] H. R. Byers, Meteorological Conditions during the March, 1936, and Other Notable Floods, *Journ. New England Water Works Assn.*, March, 1937.

FIG. 15—Successive developments in the weather situation March 12 to 17, 1936, in the eastern United States (8 p. m. air-mass maps, courtesy Massachusetts Institute of Technology.)

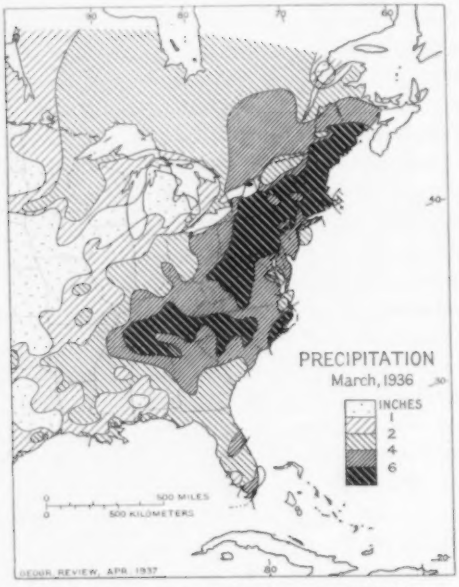


FIG. 16—Total precipitation in the eastern United States, March, 1936. (From *Monthly Weather Rev.*, March, 1936.)

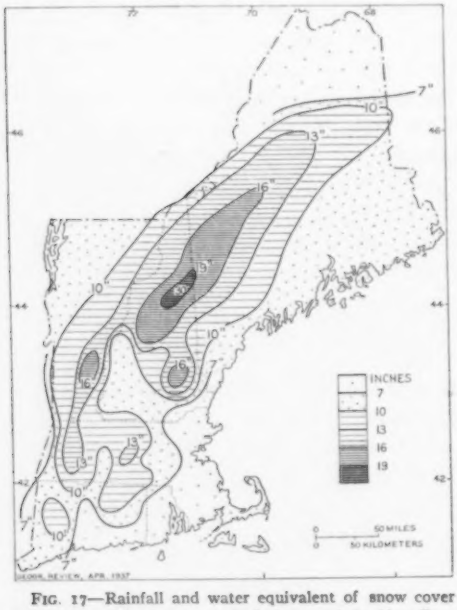


FIG. 17—Rainfall and water equivalent of snow cover melted from March 9 to 21, inclusive, 1936, in New England. (From Climatic Data, U. S. Weather Bureau, New England Section, March, 1936.)

lower levels was often 20 to 40 miles an hour and at higher levels twice these speeds.

A complicating factor was the deep and dense snow cover and heavily frozen rivers at the beginning of March (Fig. 18). Ice was reported in all the northern rivers and in the headwaters of the Ohio. The Allegheny was frozen, New Jersey rivers were ice-jammed, and the West Virginia rivers were filled with floating ice.

In January, 1936, precipitation was above normal everywhere in the section of the country considered—New England, Middle Atlantic States, Virginia, and the upper Ohio Valley. Temperature everywhere averaged below normal. In the last decade of the month temperatures below zero were reported everywhere from New England to Virginia and westward, including Kentucky and Ohio, and were continued in one of the coldest Februarys on record. Precipitation during February was slightly below normal for most of the area. These conditions were favorable for freezing the ground to a depth of several inches and, therefore, conducive to floods; the greater part of the March rains was

immediately available as runoff. After the first eight days, March temperatures were 3 to 12 degrees above normal. Precipitation was well above normal in all parts except Kentucky and Ohio: in New England more than twice the normal monthly amount fell. Fortunately a week of balmy winds preceded the first heavy rains, so that the removal of the snow cover and softening of the ice were well un-

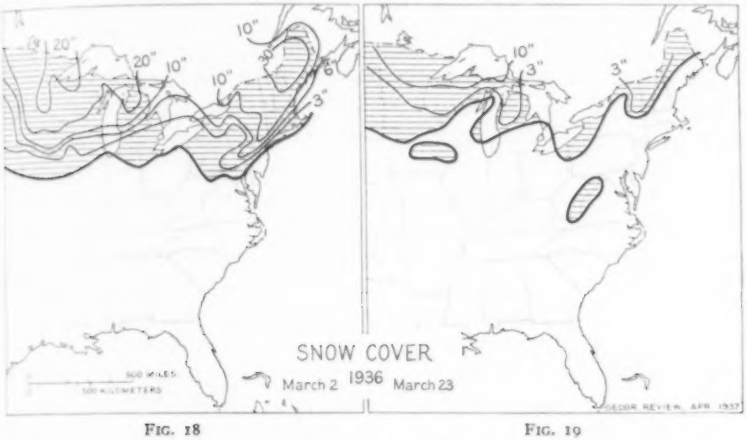


FIG. 18 FIG. 19

FIG. 18—Depth of snow on ground at 8 p. m., March 2, 1936. (From *Weekly Weather and Crop Bull.*, March 3, 1936.)

FIG. 19—Depth of snow on ground at 8 p. m., March 23, 1936. (From *Weekly Weather and Crop Bull.*, March 24, 1936.)

der way. A respite of a few days after the first downpours also permitted the crest of the snow, ice block, and rain flood to pass before the greater rains descended.

Though Pittsburgh had its worst flood on record, with a stage seven feet higher than ever before known, the local contribution to the waters was relatively small and in ice form. If the general temperatures had been only a few degrees higher, the addition of the precipitation that covered western Pennsylvania with ice or snow to the flood waters from the 5 to 7-inch rains near the crest of the Appalachians might well have added several feet to this extraordinary visitation. The trees in a north to south belt across western New York were devastated by the ice storm; and Buffalo was snowed in by an unprecedented fall, to which was added a few days later another heavy snowstorm.

New England above 2000 feet was still deeply snow-covered when the tropical wind and great rains burst upon the country on March 17; consequently a further release of snow water added to the tremendous rain, making a total of 10 to 30 inches since March 9 (Fig. 17), brought the chief rivers to unprecedented stages. The headwaters in the mountains, however, were so well protected by dense coniferous

forests that the snow cover was not entirely removed and acted as a good storage reservoir for the rain. At Pinkham Notch the depth of snow cover was reduced from 48 inches on the 9th to 16.2 inches on the 21st, and on Mt. Washington summit from 20.5 inches to only 1 inch.[17] Accordingly, though great slush slides occurred, the floods in the mountains were not exceptional.

The Johnstown Flood of 1889

The Johnstown flood of 1889, like the flood of 1936, was caused by the meeting of a strong flow of tropical Atlantic air from the southeast with a standing front of modified though cold polar continental air near the crest of the central Appalachians.[18] Although the disaster at Johnstown and vicinity, in which a total of some 9000 people were drowned, was due chiefly to the bursting of a dam, the rainfall, averaging 6.2 inches over the Johnstown Valley,[19] is the outstanding occurence of its kind over the central Appalachians.[20] The maximum was 9.8 inches, falling in 31 hours. Russell computes that 1.9 cubic miles of water fell on the Susquehanna watershed, 1 cubic mile on the Potomac, and 0.9 cubic mile on the Allegheny and Monongahela watersheds. The rain front swept from the Atlantic to Lake Erie in 16 hours.[21]

The New England and New York Floods of November, 1927

The New England and New York floods of November, 1927, were caused in much the same manner as the widespread flood of 1936 and the less general one of 1889. The chief flood was due to the rain of November 3 to 4, when exceptional rains fell on soil thoroughly soaked by the tropical storm a fortnight before. A western low and a weak tropical cyclone joined forces in a deep current of tropical air, which was forced northward at increasing speed by a great high centered near Newfoundland. Part of the strength of this high, which at one time reached 30.72 inches, was derived from a flow of cold air from the Greenland region. The rainfall was due to convergence in the tropical cyclone, to general convergence of the tropical wind in New England, to ascent, and convection touched off by it, both over highlands, and a cold air mass banked up behind the Green Mountains.

With the passage of the tropical cyclone the night of the 3rd–4th, a narrow belt of excessive rain drove northward through Rhode Island and eastern Massachusetts. Orographic plus frontal effects caused

[17] For further details see Baldwin and Brooks, *op. cit.*

[18] H. R. Byers: Meteorological Conditions during the March, 1936, and Other Notable Floods, *loc. cit.*

[19] T. Russell: The Johnstown Flood, *Monthly Weather Rev.*, Vol. 17, 1889, pp. 117–119.

[20] M. W. Hayes: Some Flood Producing Storms of the Atlantic Seaboard, *Journ. New England Water Works Assn.*, March, 1937.

[21] Russell, *op. cit.*, Chart 6.

more than 7 inches of rainfall in western Massachusetts and up to 9.65 in Vermont, of which 8.77 fell in one day. Still heavier rains evidently occurred in the mountains, judging from the tremendous quantities of water discharged both from the Green Mountains and from the White Mountains, possibly up to 15 inches.[22]

The New York State flood of July, 1935,[23] had many features in common with the New England flood. Reference might also be made to the Southeastern floods of July, 1916, in which two slowly moving hurricanes went to pieces in the southern Appalachians, July 10 and 15.[24]

Conclusion

Great floods may occur in the eastern United States at any time of the year, for there is always an extensive warm-water surface near by, from which great volumes of vapor may be transported, while, not far distant, throughout the year there are cold surfaces to furnish moving wedges of cold air to elevate the tropical air. The polar air masses engage the tropical masses normally every few days, and rains fall. The great floods occur, however, only when a persistent high over the western Atlantic sends the tropical air inland for days in succession, and then only when the polar masses meet and elevate the tropical air over the same area or region for one to several days in succession or on repeated occasions. Topography plays an important role in determining where slowly moving fronts will stall: sometimes even minor divides are effective. Snow cover seldom contributes much to great floods, though by helping to keep cold air masses cold it may contribute to stalling and to the maintenance of the temperature contrast between the cold and the warm air masses.

What can man do about great floods?[25] He cannot change the amount of rain that will fall; but he can change the rate at which it will run off. He cannot change the amount of snow that will fall; but by dense evergreen foliage he can hinder it from reaching the ground and, once on the ground, from being converted into rapid runoff. Once the water is running off, he can hold back some of it by numerous dams on small streams and by larger dams below; and, by adequate

[22] For an account of the flood in the Connecticut Valley see J. W. Goldthwait: The Gathering of Floods in the Connecticut River System, *Geogr. Rev.*, Vol. 18, 1928, pp. 438–445. For details as to the causes of the November floods see J. H. Weber and C. F. Brooks: The Weather-Map Story of the Flooding Rainstorm of New England and Adjoining Regions, November 3–4, 1927, *Journ., New England Water Works Assn.*, Vol. 42, 1928, pp. 91–103. For the rainfall and comparison with other flooding storms in New England see X. H. Goodnough: Rainfall in New England During the Storm of November 3 and 4, 1927, *ibid.*, Vol. 42, pp. 150–188, Vol. 44, pp. 119–156.

[23] Hollister Johnson: The New York State Flood of July 1935, *U. S. Geol. Survey, Water-Supply Paper 773-E*, Washington, 1936, pp. 233–268.

[24] A. J. Henry: Floods in the East Gulf and South Atlantic States, July, 1916, *Monthly Weather Rev.*, Vol. 44, 1916, pp. 466–476.

[25] A symposium on recent eastern floods and the national aspects of flood control held in Pittsburgh October 13 and 14, 1936, is summarized in *Civil Engineering*, Vol. 7, 1937, pp. 25–32, and published in full in the March issue of *Proceedings of the American Society of Civil Engineers*.

measurements of rainfall and condition of the ground and by a rapid system of collecting reports, he can compute in advance when and how high the waters will rise. He can confine the rivers by levees, but he must provide for temporary diversion of excess waters over capacious lowlands. He can straighten the stream channels to hasten the water on its way; but, without great care, such relief upstream may mean a greater flood downstream. The operation of control dams and diversions could be more intelligently directed if great rains could be foreseen more than a day or two in advance. This is not impossible, and studies in long-range forecasting are already rather promising. But whatever success may be attainable in weather and river-stage forecasting the main point to bear in mind is that ten-inch rains do fall, sometimes in a few hours, and that if man does not control the speed with which the water reaches the streams and then whither it goes floods will devastate the valleys.

THE DISTRIBUTION OF PASTURE IN AUSTRALIA

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IT has often been remarked that the best map to aid the geographer in forecasting settlement in a new country is one of the natural vegetation. Many attempts have been made to produce such maps of Australia: among them may be mentioned maps by Diels,[1] Taylor,[2] and Lane-Poole.[3] Only in recent years, however, has an official survey been compiled; and the present review is chiefly concerned with Dr. A. McTaggart's "Pasture Map of Australia"[4] an appraisal of the pastoral resources of the country based on considerations of the vegetative climax types. As the main industry in Australia is based on sheep, it is unnecessary to stress the importance of a scientific study of the pastures.

In Figure 1 I have simplified McTaggart's map considerably and have laid stress on the chief additions to our knowledge embodied in it. In three respects this map is quite original. It defines the distribution of the two chief pastures of arid and semiarid Australia—the saltbush and Mitchell grass associations. Furthermore, it shows where introduced (exotic) grasses and clovers are abundant enough to appear on a generalized map of the continent. Below the main map I have inserted three small maps correlating the vegetation with the controlling rainfall and with the sheep and cattle industries. Our knowledge of all three of these is, I venture to state, more accurate than that of the vegetation map and therefore is a check on it. Moreover, the pastoral industry in Australia has been relatively stable for a decade or so, which means that the squatters (ranchers) have explored practically all the possibilities for pastoral occupation. Of course, many regions may be still more densely occupied as better water supply and so on are arranged; but I see no likelihood that the general character of the inset cattle and sheep maps will be notably altered for many years.

The twelve main classes of pasture shown are based partly on McTaggart's map and partly on my own knowledge of the country.[5] McTaggart uses 14 classes, the arrangement of which is not obvious to me. The order in Figure 1 and Table I is about that of their value in the pastoral industry.

Most of the classes in Table I are readily differentiated, but I have separated from Class 6 some regions (labeled 6*a*) with much the same climate and poor sandy soils in which brigalow and suchlike acacias are somewhat more abundant than in Class 6.[6] It is difficult at present to say which is the better country for pastoral occupation. It is also rather hard to draw the line between Classes 9 and 10, the somewhat heavier rain in the north being balanced by the greater evaporation there.[7]

[1] L. Diels: Die Pflanzenwelt von West-Australien südlich des Wendekreises (Die Vegetation der Erde, Vol. 7), Leipzig, 1906, map at end.

[2] Griffith Taylor: Australia in Its Physiographic and Economic Aspects (The Oxford Geographies), Oxford, 1911, Fig. 16 (p. 55); *idem:* The Australian Environment, *Commonwealth of Australia Advisory Council of Science and Industry Memoir No. 1*, Melbourne, 1918, Fig. 10 (p. 27); *idem:* Agricultural Regions of Australia, *Econ. Geogr.*, Vol. 6, 1930, pp. 109–134 and 213–242, Fig. 5 (p. 114); *idem:* Australia, Including Chapters on New Zealand and Neighboring Islands: A Geography Reader, edited by Isaiah Bowman, New York, etc., 1931, Fig. 38 (p. 71).

[3] C. E. Lane-Poole: Commonwealth Handbook, Third British Empire Forestry Conference, Australia and New Zealand, 1928, Canberra, n. d., map No. 6 (at end), by Commonwealth Forestry Bureau.

[4] Accompanying A. McTaggart: A Survey of the Pastures of Australia, *Commonwealth of Australia Council for Sci. and Indust. Research Bull. No. 99*, Melbourne, 1936.

[5] Descriptions of traverses made by the writer in most parts of the continent are given in his book "Australia" (1931).

[6] See Taylor, Australia (1931), pp. 322–328.

[7] See Taylor, Australia (1931), pp. 278–282.

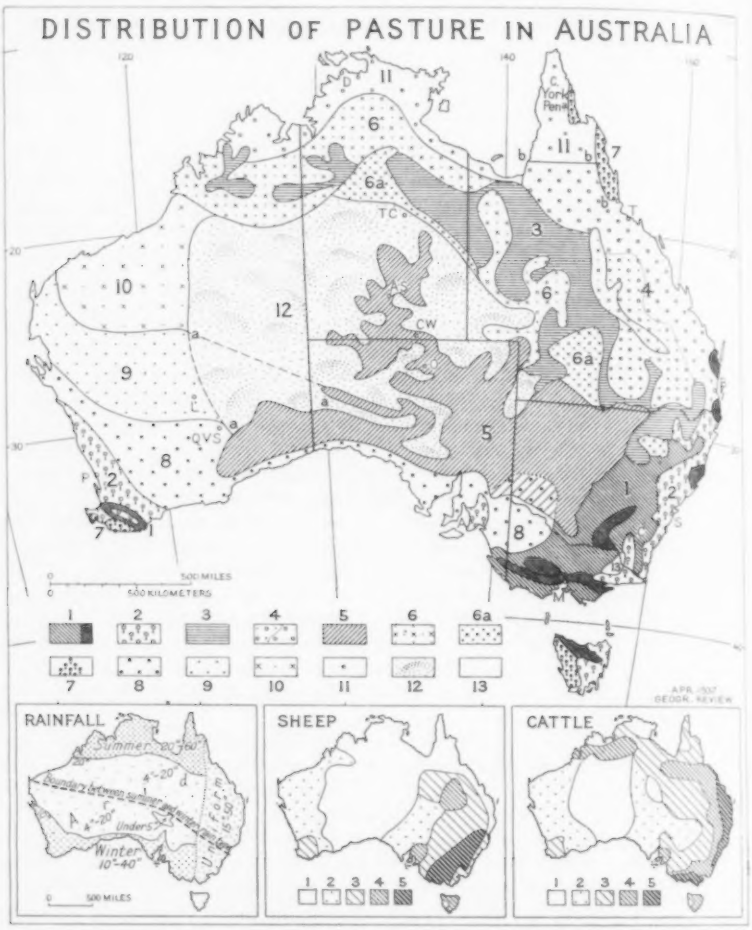


FIG. 1—Map showing distribution of the chief types of pasture in Australia (based in part on McTaggart). Classes 1 to 12 are numbered in approximate order of value: 1, temperate grassland, with differentiation of important areas of exotic grasses (closer ruling); 2, temperate forest; 3, tropical Mitchell grass; 4, open tropical forest; 5, saltbush; 6, tropical sandy grassland, distinguishing as 6a areas in which edible acacia is more abundant; 7, rain forest; 8, mallee; 9, arid mulga; 10, west sandy grassland; 11, poor open forest; 12, fixed dunes; 13, alpine. Scale approximately 1 : 40,000,000. The three inset maps show amount and distribution of rainfall and density of livestock (1, none; 2, sparse; 3, fair; 4, good; 5, dense).

The zone of Mitchell grass (3) occupies a fairly definite climatic belt on the margin of the widespread semidesert and desert areas. Its alternation with Class 6 is clearly due to edaphic control. Indeed, locally, the patches of 6 in Queensland are called "desert." Mitchell grass (*Astrebla pectinata*) grows chiefly on soils resulting from the weathering of limestone or basalt. The so-called desert (6) occupies the arenaceous soils. This sharp transition from good to bad sheep country always strikes the traveler in northwestern Queensland.

The extension of the saltbush association as far north as Tennant Creek (North-

ern Territory) and westward from Charlotte Waters to the very border of Western Australia is new to me. The fact that so few stock occupy these areas shows that they cannot offer much pasturage in ordinary years. In general saltbush flourishes best in the region of winter rains (see inset map). In New South Wales the saltbush country is the chief habitat of the merino. In the Nullarbor "karst" (Western

TABLE I—MAIN TYPES OF AUSTRALIAN PASTURE

A, More Important Pastoral Areas

CLASS	RAIN* (*In.*)	STOCK†	CHIEF PLANTS	LOCALITY
1 Temperate Grassland . .	15–30 U	S	*Danthonia* sp., *Stipa* sp., now much clover, etc.	Victoria and central New South Wales
2 Temperate Forest . . .	30–50 U & W	C	Eucalypts originally, now much exotic grass	Southeast and southwest coasts
3 Tropical Mitchell Grass .	15–30 S	S & C	*Astrebla* and flinders grass (*Iseilema*)	North and east edges of central arid area
4 Open Tropical Forest . .	20–70 S	C	Eucalypts and acacia, with grass below	Eastern Queensland
5 Saltbush	4–10 W	S (C)	*Atriplex* with *Kochia*, *Stipa*, and edible acacia	Southern part of arid and semiarid area
6 Tropical Sandy Grassland	20–40 S	C (S)	Spear grass, kangaroo grass, and edible acacia	Northern hinterland alternating with Mitchell Grass

B, Less Important Pastoral Areas

7 Rain Forest	Over 50 U & W	C	Close-set Malayan trees in north, eucalypts in south	Small patches on coasts of little significance yet
8 Mallee	10–15 W	S	Close-set low eucalypts	South coasts, much now in wheat
9 Arid Mulga	8–10 W	S (C)	Scattered edible acacia; edible herbs after rains	West coast and hinterland
10 West Sandy Grassland .	10–20 S	C (S)	Like 9 but with less acacia and more grass	Northwest coast and hinterland
11 Poor Open Forest . . .	Over 30 S	C	Scattered small eucalypts, useless coarse grasses	North coast
12 Fixed Dunes	9–18 S & W	None	Spinifex grass (*Triodia*), some trees	Central part of the continent

*Uniform (U), summer (S), winter (W). †Sheep (S), cattle (C).

Australia) there is practically no pastoral occupation, in spite of the relatively satisfactory climate and pasturage. This is mainly due to the difficulty of obtaining permanent water on the permeable limestones.

I am unable to agree with McTaggart as regards a large triangular area (*aaa*) east of Laverton (Western Australia). McTaggart labels this area "mulga" (akin to Class 9): I have been in the vicinity several times and see no reason to doubt Lindsay's description of his journey across it in 1891–1892.[8] From Mt. Squires to Queen Victoria Spring he found high red sand dunes, though some small eucalypts and mulga were present in places. On the other hand, an area between Townsville and the Gulf of Carpentaria (*bbb*) is far superior to that in Cape York Peninsula or near Darwin: differing from McTaggart, I link it with Class 4 rather than with Class 11.

[8] See Taylor, Australia (1931), Fig. 137 (p. 251).

In parts of the wheat and dairy country of the south and east the native vegetation has very largely vanished. McTaggart describes the planting of grasses such as perennial rye grass (*Lolium*), *Paspalum dilatatum*, and cocksfoot, together with clovers such as *Trifolium fragiferum* and alsike, in many of the wetter parts of the continent. The distribution of these small areas of exotic plants is indicated on the accompanying large map.

Study of maps dealing with pasture such as McTaggart's or with soils such as Prescott's[9] shows us that many factors must be considered before we can satisfactorily explain the distribution of the pastoral industry in Australia.

[9] J. A. Prescott: The Soils of Australia in Relation to Vegetation and Climate, *Commonwealth of Australia Council for Sci. and Indust. Research Bull. No. 52*, Melbourne, 1931, "Soil Map," at end. See also Griffith Taylor: The Soils of Australia in Relation to Topography and Climate, *Geogr. Rev.*, Vol. 23, 1933, pp. 108–113.

NOTES ON THE FINDINGS OF THE "WILLIAM SCORESBY" IN THE PERU COASTAL CURRENT*

Robert Cushman Murphy
American Museum of Natural History

THE long-awaited results of the investigations of the Royal Research Ship *William Scoresby*, carried out along the coasts of Peru and Chile between May and August, 1931, have now been published by the leader of the expedition. The field covered the littoral waters between Corral and the Gulf of Guayaquil, with a maximum offshore extension of about 200 miles.

"With great diffidence," Gunther has accepted the view of "the leading German authorities Hoffmann, Krümmel, and Schott" and has abandoned the name Humboldt Current in favor of the geographic designation. Peru Current, he tells us, is historically preferable; up to the middle of the nineteenth century two currents—coastal and oceanic—were generally recognized, and a regional nomenclature was employed. We now know that the current close inshore and under the nearly continual influence of upwelling has little in common, either physically, chemically, or biologically, with the adjacent open ocean, a proximal zone of which Gunther would call the Peru Oceanic Current. In the latter the surface strata are impoverished because they are cut off from supplies of nutrient salts by a well marked underlying discontinuity layer. Near shore, on the other hand, this condition is rectified by upwelling. Furthermore, the cool inshore water contributes to the formation of cloud over the littoral, a fact which, in turn, partly determines the high concentration of diatoms in the relatively weakly illuminated surface water. This thick growth of plant life gives to the coastal current a greenish color and accounts for its famous richness of animal life. In the outlying ocean the water is blue or indigo and relatively poor in life. Finally, the coastal current has both a greater velocity and a northerly direction, whereas the waters of the oceanic current tend to set towards the west, most markedly off northern Peru.

Curiously, the question of nomenclature seems to have been befogged in recent published discussion by personal animus. Geographic names will hardly become adopted by fiat and, despite former confusion, it is noteworthy that Gunther's characterization of "Peru Coastal Current" is wholly synonymous with Murphy's restricted and specific definition of "Humboldt Current."[1]

Knowledge of a current of sufficient strength to be of concern to navigators dates from about 1522. By 1553 Cieza de Leon had pointed out that the favorable months for a southward voyage were January, February, and March, when northerly winds are frequent. The low temperature of the coastal current, with at least an indirect reference to the warm countercurrent, was noted by Acosta in 1608. It remained for Humboldt, at the surprisingly late date of 1802, to dip the first thermometer into the cool water. This natural philosopher's other scientific observations on the current were, however, of minor importance, while his associated theory attributing the low temperature to antarctic origin has been jettisoned. The last fact, coupled with the convenience of a geographic name, seems to furnish the basis for rejecting the patronymic. Nevertheless, "Humboldt Current" has become increasingly understood as a particular set of phenomena, whereas "Peru Current"

*E. R. Gunther: A Report on Oceanographical Investigations in the Peru Coastal Current, *Discovery Reports, Vol. 13*, 1936, pp. 107–276. Dr Gunther's paper "Variations in Behaviour of the Peru Coastal Current—with an Historical Introduction" in the *Geographical Journal* (Vol. 88, 1936, pp. 37–65) comprises a useful abstract of the *Discovery* report together with historical information not included in the larger work.

[1] R. C. Murphy: Oceanic Birds of South America (2 vols.), New York, 1936, Vol. 1, p. 95.

proves to be an oceanographic twin. De Tessan[2] is credited with the first description of upwelling as an explanation of the low temperature along the shores of Chile and Peru. The relation between this phenomenon and the effect of the earth's rotation, at any rate in its mathematical aspects, has been worked out chiefly since the opening of the present century.

With reference to upwelling, the findings of the *William Scoresby* are in fair agreement with those of the *Carnegie*, as reported by Sverdrup.[3] Salinity determinations show that the source of cold water reaching the surface lies at depths between 100 and 360 meters, the average being close to the former figure. Below these levels is a southward-flowing current composed of mixed subtropical and subantarctic water. Still lower (700 m.) is a layer of antarctic intermediate water which, of course, makes no contribution to the upper strata. The breadth of the zone of predominant upwelling may be taken as that throughout which the volume of plankton catch remains substantially the same as close inshore and also as that in which the surface isotherms tend to parallel the coast rather than the lines of latitude. Gunther suggests, indeed, as the arbitrary boundary between oceanic and coastal currents, a line connecting positions at which the mean annual isotherms cease to extend east-west and begin to follow the trend of the continental shore. The coastal current would then have to be regarded as a relatively small part of the eastern limb of the South Pacific anticyclonic circulation. Nevertheless, during the whole campaign of the *William Scoresby* the influence of coastal phenomena extended over a wider area than has usually been granted to the Peru Coastal Current (± 100 miles from shore).

The current is essentially a single-sided divergence line along which waters from surface and depths are being constantly mixed, drawn off, and replaced by fresh supplies. During intervals in which the current converges with the coast, upwelling is temporarily checked and the cool water tends to subside. The term subsidence, as used by the author, relates to a reversion of the layers of water toward a condition of horizontal stratification and is to be distinguished from the sinking of surface water because of an accession of density. An understanding of the relationship between upwelling and subsidence makes it allowable to translate the Peruvian fishermen's tradition of a horizontal swinging of the cold current, toward or away from shore, into the conception of a "vertical swing," as the rising or settling of inshore water is balanced against the force and direction of local wind or other influences.

The processes that bring about the divergence of surface water and its corollary, upwelling, are limited to (1) aspiration, or the suctional effect of winds and drift out at sea; (2) the deflecting force of the varying component in the earth's rotational velocity; (3) offshore wind. The last is certainly so unimportant as to be negligible. It is difficult to segregate the effects of the other two influences. During the survey of the *William Scoresby* some appearance of upwelling was encountered at every locality examined, even under meteorological and hydrological conditions that locally looked unfavorable to it.

Northerly drift for the current as a whole probably averages less than ten miles a day, and popular belief in its strength is exaggerated. Off Peru, however, the surface layers of water are more homogeneous and the current is stronger than along the Chilean coast. To northward of latitude 40° S. the coastal winds tend to parallel the shore, showing a deviation from the normal trade-wind direction that is characteristic of the continental periphery of the South Pacific high-pressure area.

In the coastal current the northerly drift diminishes with distance from land; but, since southerly winds are stronger and more certain over the open sea, distance

[2] Cf. also Murphy, *op. cit.*, Vol. 1, pp. 267 and 268.

[3] H. U. Sverdrup: Some Oceanographic Results of the *Carnegie's* work in the Pacific—the Peruvian Current. *Trans. Amer. Geophys. Union, Tenth Ann. Meeting, April 25 and 26, 1929; Eleventh Ann. Meeting, May 1 and 2, 1930*, Natl. Research Council, Washington, 1930, pp. 257–264.

from land is attended by increasing westward set. There is also slight but definite evidence, to be referred to below, of an outlying countercurrent off Peru.

In its course the coastal current crosses the convergence of subantarctic and subtropical water, which lies close to the 31st parallel in longitude 100° W., but curves sharply northward on approaching the Chilean coast. It is along this convergence that the subantarctic surface water sinks below. The water of the current shows a slightly greater total access of warmth toward the north than has been credited by recent writers. Nevertheless, in Gunther's charts the isotherm of 15° C. can be traced along most of the coast, close inshore, from Coquimbo almost to Pisco.

Eddies between the current and parts of the shore are not unusual. These are probably in part compensatory, for during the *William Scoresby's* cruise they were found associated with regions of excessive divergence. They are cyclonic (as distinguished from the larger anticyclonic gyrations), and near them upwelling is reduced. Such lesser phenomena of the hydrological system deserve further examination because of their important bearing on biological productivity.

In the southern summer, following the Christmas season, the transgressing northeast trade winds regularly reverse the trend of the surface currents off northern Peru and, by driving the hot, poorly saline waters of the Equatorial Countercurrent southward, produce a notorious chain of phenomena stemming from the fact that the "Niño" flow necessarily converges with the coast.

The littoral as a whole proves somewhat less uniform than Schott, Murphy, and other writers have inferred, and during the apparently normal term of the *William Scoresby's* work many data of anomalous aspect were gathered. Upwelling, for example, proved to be far more vigorous at some points than at others; while at certain places huge wedges of warm water were found thrusting toward the coast, with cooler surface water to westward of them. In one such wedge, off San Juan, between Pisco and Mollendo, the countercurrent was strong enough to carry the research vessel southeastward against the wind. Previous observers, lacking intelligible data, have been inclined to write off similar observations under the general heading of the "weak and variable nature" of the Peru Current. In Gunther's illuminating words:

> The identification of areas where cool water at the surface was most prevalent during our survey with the regions of traditional current is no chance coincidence but a correlation to be expected. Moreover the accompaniment of westerly set is equally a corollary. Thus areas of strong current alternate with areas of negligible current, and corresponding with them, areas of active upwelling alternate with areas of reduced upwelling, each apparently falling within a system of its own. These correlations taken in conjunction with our own data make it possible to suggest that the warm water wedge represents, not one countercurrent, but two counter-currents of compensation. They look indeed as though they were each the oceanic limb of a vast anticyclonic eddy.[4]

Gunther links up the expedition data with details published by Schott in 1931[5] and with the more fragmentary experiences and speculations of other observers, going back to the year 1823. The conclusion seems clearly to be that the surface temperature along the coast normally displays a series of crests and troughs and that the temperature toward the peaks of the seaward extensions becomes as warm as the mean for surface temperatures 100 miles offshore.

The indication is scarcely to be avoided that convergence of a warm wedge of highly saline tropical water takes place either recurrently or permanently at two

[4] Gunther, Variations, p. 55.

[5] Gerhard Schott. Der Peru-Strom und seine nördlichen Nachbargebiete in normaler und anormaler Ausbildung. *Annalen der Hydrogr. und Marit. Meteorol.*, Hamburg, Vol. 59, 1931, pp. 161–169 and 200–213; Pls. 17 and 20–22.

particular points, namely near Callao and near Arica. Northerly coastal drift, on the other hand, is most pronounced in two alternating localities—off the Eten-Sechura region of northern Peru and off the San Juan region of southern Peru—and depressed surface temperatures throughout a wide area around the latter points prove them to be major upwelling centers. The latter are correlated with perennially richer plankton conditions than other parts of the coast, whereas the warm wedges are equally notable for their paucity of plankton. Both these facts suggest permanence. The fixed inflows of barren oceanic water that take place adjacent to the respective great foci of upwelling doubtless represent currents of compensation. The existence of at least two large anticyclonic swirls is thereby demonstrated (Fig. 1).

Such an analysis of the great serrations in the coastal isotherms goes far toward resolving the meaningless "vagaries" that have been emphasized in the past. The latter would include the ravages of the *aguaje* ("Callao Painter"), or discolored seas, which at times, as in 1923, characterize not only the Niño season but also the mid-winter months. The hypothesis would account likewise for the frequent inversions of both atmospheric and surface-water temperatures from north to south along the Peruvian coast, striking examples of which have been pointed out by Murphy.[6]

Gunther reports that he has been unable to form any definite views on the ultimate causes of the swirls. Since the recognition of these represents the climactic attainment of his campaign in the *William Scoresby*, it will be of interest to consider certain of the hydrodynamic possibilities.[7] For instance, the swirls bear at least a superficial and perhaps specious resemblance to the alternating vortex-and-breaker effects that develop along a fluid surface of discontinuity, whether of density or of motion. More probably, their real relationships are with the recently investigated phenomena of the "wake stream," which is defined as a free ocean current unconstrained by bed or banks and corresponding to a jet in experimental hydrodynamics.

The attractiveness of the former of these two suggestions rests on the doubtful assertion that the relatively slight temperature differences involved would aid in accounting for the great spatial extent of the observed interactions in the oceanic surface layers. Within a fluid a surface of discontinuity is unstable. It changes into wave form, and the waves develop into three-dimensional vortices. Ultimately the surface of discontinuity breaks down into a multitude of eddies; but subsequent action may establish a new plane of separation, and the cycle will be repeated.

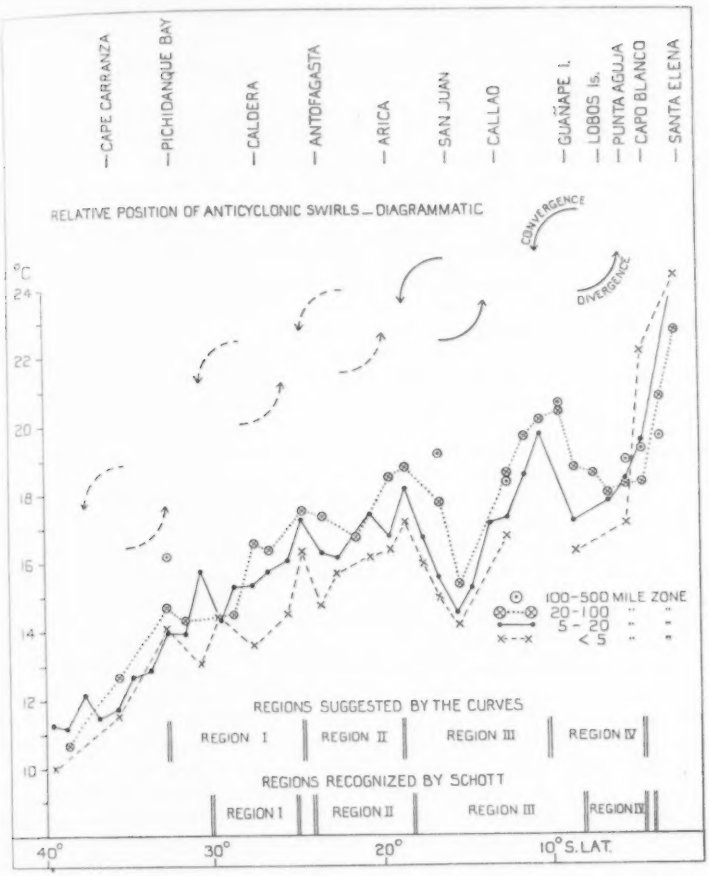
Banerji and Ghatage[8] have studied discontinuity in density by causing rectangular or cylindrical columns of water to have a different temperature from the adjoining liquid, while discontinuity in motion as well as density was introduced into their tests by the expedient of making streams of different temperatures meet at various angles. In both circumstances they found that a surface of discontinuity resolves itself into cubic moving vortices, whose relations to the degree of temperature disparity and its slope, the velocities of the incident currents, and other factors they have ingeniously analyzed by photographing in horizontal and vertical section the resulting streamlines, after contriving to color one part of the liquid or the plane dividing the two parts.

These authors point out that instability at the surface of discontinuity causes alternating crests and troughs to assume the form of breakers rotating in opposite directions. The "crests," which protrude into warm water and have cold cores, show a more pronounced development than the "troughs," which extend into the cooler water. The former, they hold, always tend to roll around themselves and to

[6] *Op. cit.*, Vol. 1, p. 96.

[7] In presenting these comments the reviewer wishes to acknowledge with grateful appreciation the opportunities he has had for discussion with Mr. John Hays Hammond, Jr., Dr. Henry B. Bigelow, Dr. Columbus O'Donnell Iselin, and Professor John Leighly.

[8] S. K. Banerji and V. M. Ghatage: On Discontinuous Fluid Motion under Different Thermal Conditions, *Indian Journ. of Physics*, Vol. 7, Part III (and *Proc. Indian Assn. Cultiv. Sci.*, Vol. 16, Part III), Art. 15, pp. 165–228, Pls. 11–20.



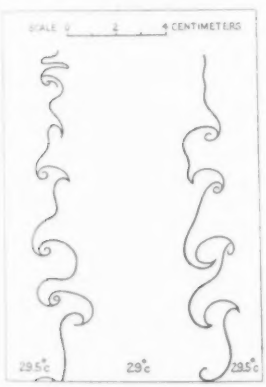


FIG. 1 (above)—Gunther's diagram illustrating an indicated permanence of the upwelling centers in the Peru Coastal Current between central Chile and northern Peru (Fig. 66, p. 217, of "A Report on Oceanographical Investigations in the Peru Coastal Current"). The peaks and troughs of temperature alignment are shown in relation to the anticyclonic swirls, of which those along the southern part of the coast have been hypothecated. Below the three curves, the four postulated centers of upwelling are identified with the regions recognized by Schott.

FIG. 2 (left)—Form of the surface of discontinuity when the temperature of water inside a cylinder is very slightly lower than in the tank outside. The vortical "crests" protrude outward into the warmer water; the breaker-like "troughs" extend inward. Drawn from a photograph by Banerji and Ghatage (Pl. XIII, Fig. 44) made immediately after a thin metal cylinder separating the water of different temperatures had been withdrawn by clockwork.

grow into well defined spiral vortices, while the troughs undergo slower development and merely acquire the shape of breakers (Fig. 2).

In the direction of motion the vortices show a progressive increase in amplitude and in number of convolutions. As regards slope, an increase in inclination of the surface of discontinuity to the horizontal leads to reduction in size of the vortices. With increase in the temperature disparity at the surface of discontinuity, the vortices develop more rapidly. The smaller the difference in temperature, however, or the slighter the slope, the greater becomes the diameter of the vortices. Their bulk enlarges rapidly as the temperature difference is reduced below 5° C., increasing towards an infinitely large value as it approaches zero.

The experiments of Banerji and Ghatage were made in homogeneous water, whereas ocean currents are stable and stratified. The modification presumably introduced by this fact would be to magnify the horizontal aspect of the eddies and to reduce almost to zero the vertical overturn that characterized the experiments. Thus the energy manifesting itself in eddy production along the edge of a current would have to be dissipated almost entirely in the form of horizontal rather than vertical eddies, and the greater the stability the larger the horizontal eddies.

So far as we can tell, the vortices described by Banerji and Ghatage are ephemeral eddies of turbulence, maintained by such agencies as inertia and viscosity rather than by forces resulting from the rotation of the earth. The swirls described by Gunther, however, are so large that they must be regarded as marine water bodies with their own circulation, and the effect of the earth's rotation would be to guide such vast movements tangentially to the gradients of density rather than across them. Furthermore, it is by no means certain that the direction of spin in the ring vortices produced by the withdrawal of the cylinder, in the experiments of Banerji and Ghatage, represents solely the reaction between masses of water of different density. The nonhomogeneous wake left by the cylinder, and the greater viscosity and hence initial advantage in velocity of the colder water pulled along in this wake, lead to inferences that appear to limit such wide application of the theory to larger movements of the sea and the atmosphere as the authors would make.

It is worthy of special note that the strong divergence areas pointed out by Gunther are situated in both instances at salients along the Peruvian coast (Pisco and Point Aguja), while the compensating tongues of warmer water approach the land precisely at intervening reëntrants (Arica-Mollendo and between Callao and Chicama). The phenomena as a whole resemble the swinging out of the Gulf Stream into the Atlantic at the Newfoundland Banks, provided due allowance is made for the hemisphere in which the respective movements take place.

Rossby[9] has recently shown that a current flowing in the oceanic troposphere would, in the southern hemisphere, give rise to a countercurrent on its right side. With the coastal limb of the Peru Current serving as the source of surface drifts of cold water northwestward from the South American shore, we should therefore expect to find countercurrents from the northwest on the right sides of the currents moving offshore. Furthermore, because of the left-hand trend shared by all of these, the curved axes of the pairs would assume a tangential relation. If this be the true explanation of the anticyclonic systems described by Gunther, each comprises a wake stream of cold water and a neighboring countercurrent necessarily warmer because of its origin out at sea and in a lower latitude. The divergent section of one swirl is causally associated with the convergent flow of its countercurrent to northward, rather than with the countercurrent to southward that appears to complete the gyratory movement. The Niño, both in its rudimentary form and in its extreme development, would also be such a countercurrent.

[9] C.-G. Rossby: Dynamics of Steady Ocean Currents in the Light of Experimental Fluid Mechanics, *Papers in Phys. Oceanog. and Meteorol.*, Cambridge and Woods Hole, Mass., Vol. 5, No. 1; reference on p. 22 and in Fig. 7.

MADAGASCAR: GREAT ISLE, RED ISLE

A BIBLIOGRAPHICAL SURVEY

Elizabeth T. Platt

. . . . . Madagascar,
presque égarée sur la carte,
. . . . . .
Terre des bœufs, terre des tombeaux,
terre mordue par les caïmans,
le sang de tes plateaux s'écoule
par les blessures de tes rivières
et rougit la mer qui te porte.
Voici montant à l'horizon
ton sol pavé de mamelons
et tes couronnes de montagnes,
tes rizières où circulent les lambes,
tes forêts et tes plantations,
tes steppes où vont des hommes nus
. . . . . .
Terre des cyclones, terre des contrastes,
. . . . . .
Madagascar, terre des sorciers,
terre des voleurs de bœufs.
. . . . . île rouge, Madagascar.

Chant Malgache[1]

"Chant Malgache" is turned to prose in the swift-moving panorama of a passage on the regular weekly airplane service between Tananarive and Broken Hill.[2] Madagascar, so lately "almost off the map," now is less than thirty-six hours from Northern Rhodesia and only nine days or less from Paris. The brief two hours over the "Great Island" reveal some of its variety—rice fields about the capital; red patches on the grayish plateau, Imérina villages whose inhabitants, wrapped in their *lambas* are sunning themselves out of doors; splashes of verdure, woods planted since French occupation; hill-crest ruins of houses and fortified places abandoned in these days of safety; ancient tombs on the heights; long lines of granite, bones of the earth sticking through the epidermis of laterite; villages increasingly rare, though ancient ditches mark cattle runs of former times; a tortured landscape, *lavaka*, deep gashes cut in the bare red flesh of the land; the immense solitudes of Bongolava, no man's land between east and west, traversed only by cattle thieves and the pursuing patrols; the Triassic depression with its colored sandstones and poor Sakalava villages of leaf huts scattered here and there among palms; darker streaks, basalt extrusions perhaps responsible for the disappearance of the oil reserves that have been sought in vain; plateau again, bush fires; wooded country where the limestone barriers act as fire guards; more denuded country, clay plains, recent sands, and the Mozambique Channel at Maintirano; ruddy coastal waters carrying a last souvenir of the "Red Isle."

Madagascar, wrote the naturalist Commerson in 1771, "est un admirable pays" which deserves "non pas un observateur . . . mais des Académies entières."[3] His wish has been fulfilled; whole Academies have put themselves to the task of interpreting the country. The student finds ample documentation on Madagascar, especially in works published in the last decade and a half, with which this survey is chiefly concerned.

Bibliography and Cartography

With the two primary desiderata—maps and bibliographies—Madagascar is well equipped. The two-volume bibliography of Grandidier published more than

[1] The stirring "Chant Malgache" from which these few lines are taken is by Robert Boudry, *La Rev. de Madagascar*, Tananarive, No. 14, April, 1936, pp. 23–34.

[2] Raymond Decary: Un voyage en avion de Madagascar en Rhodésie, *La Géographie*, Vol. 65, 1936, pp. 249–274; *idem:* Tananarive-Broken-Hill en avion, *La Rev. de Madagascar*, Tananarive, No. 12, Oct., 1935, pp. 27–84.

[3] Eugène Pittard in the preface to Henry Russilon: Un petit continent, Madagascar, Paris, 1933.

thirty years ago has been brought almost to date with the publication of a volume covering the years 1904–1933, the first in a series of bibliographies designed to cover the French colonies.[4] More than eight thousand items are included.

After the French conquest of Madagascar mapping of the island was seriously undertaken. A reconnaissance map in 26 sheets on the scale of 1 : 500,000 was issued by the Bureau Topographique de l'État Major, the first edition was completed in 1900, and since then individual sheets have been reprinted with corrections.[5] A number of reconnaissance maps covering small sections of the island have been issued on the scales of 1 : 5000, 1 : 10,000, 1 : 20,000, 1 : 50,000, and 1 : 200,000.[6] However, the most important of the topographic maps is that which is being issued on a scale of 1 : 100,000, begun in 1897. Approximately 68,000 square kilometers out of a total area of 592,000 square kilometers had been surveyed by 1931.[7] In summarizing the mapping situation in 1930, Lieutenant-Colonel de Martonne writes that perhaps ten per cent of the island is covered by precise surveys (*topographie régulière*) on the scale of 1 : 100,000, of which the greatest part (47,000 square kilometers) is one section in the center, the remainder at divers scattered points in the west; perhaps four per cent (22,000 square kilometers in the center and 3000 at Diego Suarez) is represented by compilations having the value of a less precise survey (*topographie semi-régulière*). The remainder of the colony is covered more or less completely by reconnaissance surveys (75 per cent of the area of the island) or by exploratory surveys still less accurate (11 per cent).

A statement of the progress of triangulation with maps showing the areas covered may be found in the reports of the Service Géographique de Madagascar.[8] For the island as a whole there is a three-sheet layered hypsometric map on the scale of 1 : 1,000,000 prepared by G. Grandidier and J. Hansen, which shows altitudes by seven different shadings.[9] Notable work has been done in the production of special maps such as the six-sheet "Carte forestière," on which eight types of cover are distinguished.[10] In course of publication is the geological map on the scale of 1 : 200,000, each sheet of which is accompanied by an explanatory text.[11] The Service Géographique de Madagascar has also issued a two-sheet geological map of the island.[12] Any summary of the mapping of the island must include the relative material contained in the "Atlas des colonies françaises."[13] There is a hypsometric map in three sheets on the scale of 1 : 1,500,000, and there are also maps on the scale of 1 : 4,000,000 showing geology, agriculture, meteorology, ethnography, and political divisions, with a descriptive text.

A brief outline of the cartographic history of Madagascar is shown in a series of

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[4] Guillaume Grandidier: Bibliographie de Madagascar, 1904–1933. *Bibliographie générale des colonies françaises, par G. Grandidier et E. Joucla*, Paris, 1935; Guillaume Grandidier: Bibliographie de Madagascar, 2 vols., Paris, 1905–1906.

[5] Edouard de Martonne: Panorama de la cartographie malgache, *Bull. Agence Gén. des Colonies*, Paris, Vol. 24, 1931, pp. 971–1073.

[6] For lists of these maps see Service Géographique de Madagascar: Catalogue des cartes et plans, Tananarive, July, 1931.

[7] Lieut.-Col. Laborde: La nouvelle carte à 1:100,000 et les cartes à grande échelle du Service Géographique de Madagascar, *Comptes Rendus du Congr. Internatl. de Géogr. Paris, 1931*, Vol. 1, 1932, pp. 295–302.

[8] Union Géodésique et Géophysique Internationale: *Trav. (Sec.) Assn. Internatl. de Géodésie*, Vol. 1, 1923; Vol. 5, fasc. 2, 1928, Vol. 11, fasc. 2, 1934.

[9] G. Grandidier and J. Hansen: Madagascar et Dependences d'après les travaux géographiques les plus récents, Paris, 1926; 1 : 1,000,000: 3 sheets.

[10] L. Lavauden: Carte forestière de Madagascar, Tananarive, 1931: 1 : 1,000,000: 6 sheets.

[11] Gouvernement Général de Madagascar et Dépendences: Carte géologique de reconnaissance à l'échelle du 200 000e, Tananarive, 1932 to date. The American Geographical Society has 18 sheets.

[12] Carte géologique et minière du Service des Mines (Cartes géologiques anterieures par M. Boule, 1900; E. Gautier, 1902; P. Lemoine, 1906; A. Lacroix, 1923), Service Géographique de Madagascar, 1929; 1 : 1,500,000: 2 sheets.

[13] G. Grandidier: Atlas des colonies françaises . . . . , Paris, 1934.

maps dating from the twelfth century, which have been reproduced by Decary.[14] Much cartographic material of this type is to be found in the monumental "Collection des ouvrages anciens."[15]

Geology, Physiography, and Climatology

The two major geologic divisions of Madagascar are the higher eastern crystalline massif, which forms three quarters of the island, and the lower western part formed of sedimentary rocks. The lithology and mineral deposits of the former have been described by A. Lacroix, and the stratigraphy and mineral deposits of the west by F. Blondel.[16] A detailed study of the geology of the southwestern section of the island has been made by Mlle. Basse.[17] The island affords some excellent examples of rivers capture, such as the capture of the Ranomainty by the Farandroka, the Sahambava by the Faraony, and the Ankonaby by the Namorona.[18] As recently as 1935 there was a change in the bed of the Mahajamba.[19] Madagascar would not be classed as an earthquake country according to the definition of Montessus de Ballore, but shocks of a certain violence are not unknown. Much work still remains to be done in the seismographic study of the island, but the installation, in 1927, of two seismographs is a sign of progress.[20]

In the estimation of Father Poisson, of the Observatory of

Fig. 1—Natural regions of Madagascar: 1, East, humid mountain region with forested slopes and a narrow coastal plain; 2, Alaotra-Mangoro, alluvial tree and bush covered depression; 3, Central plateau, grass covered, lateritic area, temperate climate; 4, West gently rolling plains, grass covered, with clumps of palms and woodland; 5, Sambirano valley region, surrounded by forested mountains, heavy rainfall, no dry season; 6, North, mountain region with forest and steppe cover; 7, South, arid to semiarid region covered with low tree growth and scrub (Based on Christiane Heine: Madagaskar, Hamburg, 1932. Fig. 9).

[14] Raymond Decary: Les anciennes cartes de Madagascar, *La Rev. de Madagascar*, Tananarive, No. 15, July, 1936, pp. 101–130. One obvious slip is the ascription of Gastaldi's map of 1560 to Chase Salmon Osborn, in whose work a tracing of the map was reproduced.

[15] A. Grandidier, Charles-Roux, and others: Collection des ouvrages anciens concernant Madagascar, 9 vols., Paris, 1903–1920.

[16] Madagascar *in* La géologie et les mines de la France d'outre mer, *Bur. d'Études Géol. et Minières Colon.*, Paris, 1932, pp. 293–344.

[17] Éliane Basse: Étude géologique du sud-ouest de Madagascar, *Mémoires Soc. Géol. de France*, No. 24, 1934–1935.

[18] André Lenoble: L'évolution du relief dans la falaise à l'est de Fianarantsoa (Madagascar) et ses conséquences pour le bassin du Matsiatra, *La Géographie*, Vol. 64, 1935, pp. 121–126.

[19] Raymond Decary: Le fleuve Mahajamba à Madagascar et ses captures temporaires par le Kamoro, *Comptes Rendus de l'Acad. des Sci.* [*de Paris*], Vol. 201, Nov. 18, 1935, pp. 979–982.

[20] Charles Poisson: La séismologie à Madagascar, *Annales de physique du globe de la France d'outre-mer*, Vol. 3, 1936, pp. 34–39

Tananarive, the most important element in determining the local climates of the island is the position of the north-to-south mountain barrier in relation to the atmospheric currents. The west or leeward side is warmer than the east, the differences between the two coasts reaching one and a half to two degrees in summer and five degrees in winter. He presents a map showing climatic divisions thus:[21] (1) east, with no dry season, heavy rains winter and summer; (2) northeast, with light rain in the winter, heavier rain in summer; (3) southeast, with abundant rain in winter, rather heavy in summer; (4) west, with dry season in winter, moderate rain in summer; and (5) south, with scant rain in summer and a dry winter. Of these divisions in his great work "Météorologie de Madagascar"[22] he says: "The present attempt to summarize the climatic regions of Madagascar has only a provisional character. The great climatic divisions, the pronounced differences between the humid regions of the East and the Center and West of the island are well enough known. . . . It is evident that our knowledge of the South of the island is still fragmentary, and all the hinterland included between the west coast and the edge of the central plateau remains in the dark."

The Populating of Madagascar: Man

When we turn to animate nature, Madagascar offers us one of the most alluring problems—the populating (using the term in its full biological sense) of an isolated island of large size, a "little continent." And here we may note first the foundational work "Histoire physique, naturelle et politique de Madagascar."[23] This monumental series, which bears the name of that indefatigable worker in all things Madagascan, Alfred Grandidier,[24] is to be completed in about sixty volumes: sections dealing with geography, meteorology, zoology, botany, and ethnography have been published. The section on ethnography is A. and G. Grandidier's great four-volume work in this series. Of it has been said that it does not contain a page without interest to geographers.[25] Volume I is a study of Malagasy origins, and the others deal with physical, social, and cultural characteristics of the natives.

In writing of the question of origins Dubois says: "Madagascar, as every one knows, abounds in enigmas, and without doubt it will require a long time, much research, and much groping to answer them."[26] The author had earlier presented his views in *Anthropos*.[27] On the origins of the Madagascans Mötting says: "Regarding the arrival of man in Madagascar there are two opposite views. The one accepts an African origin. Its principal proponent is the Frenchman, Ferrand. The other turns from an African stock and points to Melanesian and Indonesian origin. Its principal proponents are the Frenchmen A. and G. Grandidier."[28] Based on

[21] Charles Poisson: Les climats de Madagascar, *Comptes Rendus du Congr. Internatl. de Géogr. Paris, 1931*, Vol. 2, No. 1, 1933, pp. 333–339.

[22] Charles Poisson: Météorologie de Madagascar (Histoire physique, naturelle et politique de Madagascar, par A. et G. Grandidier, Vol. 3), Paris, 1930. Reviewed in *Quart. Journ. Royal Meteorol. Soc.*, No. 242, Vol. 47, 1931, pp. 481–482. The reviewer, who remarks that "it will remain the standard work on the climatology of Madagascar for a very long time," regrets the lack of upper-air data. Since then Henry Hubert has published a note on "La circulation de l'air atmosphérique en altitude au-dessus de Madagascar," *Comptes Rendus de l'Acad. des Sci. [de Paris]*, Vol. 198, Mar. 26, 1934, pp. 1250–1252.

[23] A. and G. Grandidier: Histoire physique, naturelle et politique de Madagascar, Paris, 1885 to date.

[24] Raymond Decary: Alfred Grandidier, explorateur de Madagascar (1836–1921), *La Rev. de Madagascar*, Tananarive, No. 16, Oct., 1936, pp. 7–35.

[25] A. and G. Grandidier: Ethnographie de Madagascar (Histoire physique, naturelle et politique de Madagascar, Vol. 4), Paris, 1901–1928; quotation in *Bibliogr. géogr. annuelle*, Vol. 18, 1908, p. 277.

[26] Henri Dubois: Populations et peuplement à Madagascar: Simple essai de mise au point, *Africa*, Vol. 6, 1933, pp. 206–219; reference on p. 206.

[27] *Idem:* Les origines de Malgaches, *Anthropos*, Vol. 21, 1926, pp. 72–126; Vol. 22, 1927, pp. 80–124.

[28] Wilhelm Mötting: Geographische Völkerkunde von Madagaskar, Dissertation, University of Hamburg, 1935, p. 8. See also Guillaume Grandidier: Madagascar, *Geogr. Rev.*, Vol. 10, 1920, pp. 197–222.

thirty-six years' observations and study while he was a missionary of the Société des Missions Evangéliques, is Rusillon's "Un petit continent," rich in local folklore, history, and customs.[29] One of the more elaborate studies of a single tribe is Linton's work on the Tanala.[30] He selected these people for study because their culture appears archaic in many respects and as yet is only slightly influenced by European contact. They occupy the southern third of the eastern massif. Nowhere do they reach the coast, although in some places they are within a day's march of the sea. They lie at the meeting place of four types of culture. From the point of view of natural resources their region is not tempting. Wild food is hard to get; agriculture involves heavy clearing; grazing is poor, and cattle do not thrive. However, the forests afford good timber, and there are considerable deposits of iron ore. Their name "Tanala" is the equivalent of "People of the forest."

Animals and Plants

The fauna of Madagascar[31] "is distinguished not by a great variety of animal forms but rather by the unusualness of the types."[32] Three groups are indubitable: certain animals with affinities and analogies to those of Africa; others more similar to Indo-Malaysian or Australian species; a certain number of types connected with South American forms. "The animals of Madagascar are in effect living types of ages past." "The most salient characteristic of the Madagascar ornithology is the localization of the species . . . and another point is the Asiatic rather than African affinity of the birds and the presence of families or genera that are found only in Madagascar." "The study of the life histories of these Madagascar birds," says an American observer, ". . . is a fertile field of study that as yet has hardly been touched and awaits a resident naturalist."[33] The Franco-English-American Zoological Expedition was in the field from April, 1929, to May, 1931, with members from the British Museum of Natural History, the Muséum Nationale d'Histoire Naturelle, and the American Museum of Natural History. Its object was to secure a collection of birds and mammals as complete as possible, and these were taken at many localities in order to give the range of the species and to show the extent of the geographical variations. The report outlines the previous work done as well as the work of the present expedition and contains a list of birds of Madagascar with notes on their distribution and habits. Maps show distribution of species. Of the birds on the small island of Europa, Poisson says that there exist a multitude of "water birds, notably boobies, sea gulls, and frigate birds; but, as Perrier de la Bathie has already noted, because of the numerous small trees they are scattered and one does not note guano deposits."[34]

"A bird's-eye view of the carpet of vegetation covering the Great Island reveals on a fawn colored background that is simply an immense herbaceous prairie, dark spots—woods, forest or thickets . . . The dark spots represent in part at least . . . all that actually remains of the primitive vegetational cover, the light base, a vegetation of a totally different origin, of recent formation which still continues to replace the first in proportion to the destruction by man and brush fires."[35] These

[29] Rusillon, *op. cit.*

[30] Ralph Linton: The Tanala, a Hill Tribe of Madagascar, *Field Museum of Nat. Hist. Publ. 317 (Anthropol. Ser., Vol. 22)*, Chicago, 1933.

[31] For a general study of the fauna of Madagascar see G. Grandidier and G. Petit: Zoologie de Madagascar, Paris, 1932.

[32] Henri Poisson: La faune malgache, *La Rev. de Madagascar*, Tananarive, No. 6, Apr., 1934, pp. 69–104.

[33] A. L. Rand: The Distribution and Habits of Madagascar Birds: Summary of the Field Notes of the Mission Zoologique Franco-Anglo-Américaine à Madagascar, *Bull. Amer. Museum of Nat. Hist.*, Vol. 72, 1936, pp. 143–499; reference on p. 148.

[34] Henri Poisson: Routes de terre et de mer à Madagascar, *Bull. Agence Gén. des Colonies*, Paris, Vol. 26, 1933, pp. 741–809; reference on p. 763.

[35] H. Perrier de la Bathie: Biogéographie des plantes de Madagascar, Paris, 1936, p. 7.

two vegetations have nothing in common. The traces of the old flora are almost entirely constituted of ligneous vegetation, extraordinarily rich in species, all endemic, whose floristic composition varies with the least change in soil, station or climate. The recent flora, he states, on the contrary, is composed only of common species, ubiquitous and introduced, with some rapidly spreading autochthons—all with few exceptions, herbaceous plants—almost indifferent to change in conditions of their milieu. From the point of floristic composition the diversity of primitive vegetation is very great. Vestiges of more than six thousand endemic species are known, and doubtless more remain to be discovered. Remains of primitive vegetation still cover three-tenths of the area of the island. There are extensions in the northeast on eastern slopes, on several mountain massifs, and in the plains of the southwest. Elsewhere there are only small areas of more or less importance. A detailed study of the phytogeography of the southwestern area has been made by Éliane Basse and includes a map showing the distribution of the principal plant associations.[36] An effort has been made to introduce into the United States the rare, rubber-yielding plant, *Euphorbia intisy*.[37]

A planimetric study by Lavauden of the forest map noted above shows that about sixteen per cent of the island is wooded.[38] He agrees with the belief that the island was once entirely wooded and cites as one bit of evidence the innumerable place names that bear witness to the existence of an ancient forest where such is now unknown. Heim[39] estimates that since the French occupation in 1896 seven to eight million hectares of forest have been destroyed by "the red tooth of fire" that "kills the savana and devours it."[40] The rapidity of the destruction in spite of improved conditions in the practice of tavy is disquieting. On the other hand, the government through its forest service has carried out much afforestation work and is earnestly striving for forest improvement.[41]

Land Utilization

In general Madagascar is not a fertile country, as so much of its surface is covered with laterite. Its soils, however, are still imperfectly known;[42] but recent issues of the "Notice explicative," accompanying the geological map 1 : 200,000, contain sections describing the soils of the respective areas. Pending the carrying out of soil surveys, what means are available for determining the agricultural value of soils? Perrier de la Bathie answers the question by study of the vegetational cover. In his estimation the lands where continued cultivation may be carried on without rapidly exhausting the soils are scarcely more than eight million hectares in extent. They consist primarily of fluvial or volcanic deposits. In the soil regions as in the climatic regions there are five main divisions—east, central, west, south, and the Sambirano region.

In the east, with its abundant rainfall and rough narrow valleys, soils range from very poor to very fertile. More than nine-tenths of the area is a laterite, easily recog-

[36] Éliane Basse: Les groupements végetaux du Sud-Ouest de Madagascar, *Annales des Sci. Naturelles—Botanique*, Ser. 10, Vol. 16, 1934, pp. 95–228.

[37] C. F. Swingle: Plant Hunting in Madagascar, *Scientific Monthly*, Vol. 32, 1931, pp. 322–345.

[38] L. Lavauden: Le déboisement et la végétation de Madagascar, *Rev. de Botanique Appliquée et d'Agric. Tropicale*, No. 122, Vol. 11, 1931, pp. 817–824.

[39] Roger Heim: L'état actuel des dévastations forestières à Madagascar, *ibid.*, No. 166, Vol. 15, 1935, pp. 418–426. On the effect of the practice of tavy on the forests see also Henri Humbert: La destruction d'une flore insulaire par le feu . . . , *Mémoires Acad. Malgache*, Tananarive, fasc. 5, 1927; G. Petit: Cultures extensives à Madagascar et disparition de la forêt orientale, *Bull. Assn. de Géographes Français*, No. 77, March, 1934, pp. 35–37.

[40] Boudry, *op. cit.*, p. 25.

[41] M. Canaby: Les forêts de Madagascar, *Rev. de Géogr. Commerciale*, Bordeaux, Vol. 57, 1933, pp. 62–80.

[42] Henri Besairie: L'étude des sols à Madagascar, *Bull. Économique Trimestriel*, Tananarive, No. 4 (N.S.), 1935, pp. 296–297.

nized by its reddish color, covered in part by primitive forest and in part by grass but more often by a secondary growth of shrub. These laterites are not suited to agriculture. A better terrain, but one demanding expensive reclamation, is afforded by the marshlands. The volcanic material not yet transformed into laterites is readily distinguished by its luxuriant vegetation and black color. Its area is entirely under cultivation, including good plantations of coffee or vanilla. The alluvial lands also are almost wholly cultivated and devoted to prosperous plantations.

The central sections consist of the massifs above 800 meters, characterized by temperate climate with two seasons—rainy and warm, dry and cold. About 98 per cent of the area is covered with a laterite, drier and more compact than that of the east, with some volcanic and some alluvial deposits. The two latter lands, the most fertile of the region, are those ordinarily devoted to cultivation. The area more or less cultivable in the whole region is about 350,000 hectares and is occupied for the most part by native cultivation. These lands offer few resources for European colonization. However, in the north and south are fertile lands still unoccupied.

The Sambirano region of the northwest (see Fig. 1) is a small area that is somewhat analogous to the east. Most of the land is alluvium. Here is grown the only cacao produced on the island. The western region has, as noted elsewhere, a warmer climate than that of the east, with two seasons—one rainy from November to March, the other dry. Its valleys are often flooded. Potential areas for cultivation are found in the deltas of the Sofia, Mahajamba, Bemarivo, Betsiboka, Manambola, Tsiribihina, and Mangoky. These regions have the advantage of being admirably situated for shipping products and easily irrigated. The author estimates that they are capable of sustaining a population ten times greater than that of the entire island at present. "The West, which is still uninhabited and uncultivated, is, however, the section of the Island where future development is most certain."[43]

European colonization has centered on the east coast between Tamatave and Farafangana, but the Sambirano region and the island of Nosy Bé are becoming centers of European colonization. Among the provinces where it has been important are: Tamatave (23,000 acres), Mananjary (20,000), Moramanga (11,000), Majunga (11,000), Diego Suarez (8000), Comores (7000), and Nosy Bé (6000).[44]

The southwestern section of the island is a dry, flat subdesert area; but of it Perrier de la Bathie,[45] in analyzing the causes of the recurrent famines and their possible amelioration, says that the soils are perhaps the richest in the entire island. The famines are attributed to two principal factors: periodic droughts and primitive practices of agriculture. There are lands that would be immediately cultivable with irrigation in the basins of the Menarandra, Manambovo, and Mandrare. Petit discounts the importance of the prickly pear (Opuntia) as a resource in time of famine[46] and advocates ridding the lands of the plant. He advises development of the water resources of the south as a safeguard against famine. On the other hand Decary[47] believes the prickly pear should be maintained. He says: "It is possible that in the Mahafaly country or in the Tulear region where the natives present a

[43] H. Perrier de la Bathie: Des sols de Madagascar et des plantes qui en indiquent la valeur, *Rev. de Botanique Appliquée et d'Agric. Tropicale*, Nos. 156–157, Vol. 14, 1934, pp. 756–779; reference on p. 775.

[44] Jean Adam: La mise en valeur agricole de Madagascar, *L'Agric. Pratique des Pays Chauds*, Paris, No. 10 (N.S.), 1931, pp. 297–308. For additional information on Nosy Bé see H. Perrier de la Bathie: Végétation, sols, et cultures de trois Iles de la côte N W de Madagascar [Nossy-Bé, Nossy-Faly, Nossy-Mitsiou], *Rev. de Botanique Appliquée et d'Agric. Tropicale*, Nos. 141 and 142, Vol. 13, 1933, pp. 313–319 and 409–415.

[45] H. Perrier de la Bathie: Les famines du sud-ouest de Madagascar, causes et remèdes, *Rev. de Botanique Appliquée et d'Agric. Tropicale*, No. 151, Vol. 14, 1934, pp. 173–186.

[46] G. Petit: La disparition des *Opuntia* et les famines périodiques dans le sud de Madagascar, *Bull. Assn. de Géographes Français*, No. 77, March, 1934, pp. 37–39.

[47] Raymond Decary: L'Androy, extrême sud de Madagascar: Essai de monographie régionale, I. Géogr. Physique et Humaine, Paris, 1930, p. 206.

superior development to that of Antandroy and where colonization is rather developed the destruction of the *raiketa* (Opuntia) might be a good thing. But this conclusion should not be generalized *a priori* and extended to Antandroy." Development of the water resources of the southern section of the island is considered in more detail by Decary[48] and in other sections of the island by Reynier.[49] From the southern section of the island has come much of the supply of the castor bean, which has been increasingly utilized for aviation purposes.[50] The territories of the extreme south of Antandroy have furnished almost all the exported product.

In addition to products grown for home consumption, such as rice, manioc, maize, and beans, there are exports of coffee, maize, manioc, tobacco, sisal, sugar, and rum—all sent to France. Besides these raffia, vanilla, cloves, and cape peas are found in foreign markets.[51]

The fishing industries of the waters surrounding the island as well as of the fresh waters have been the subject of a monograph by Petit.[52]

This survey may be concluded by brief reference to some urban and related developments. Tananarive,[53] which "at the end of the nineteenth century was only a group of villages on the three hills in the shape of a Y is today a city of 100,000 inhabitants,"[54] a healthy, picturesque place. Tamatave,[55] Majunga, Antsirabé[56] are real garden cities. "Everywhere large programs of town planning are being carried out."[57]

Progress in aerial transportation has already been mentioned: railroad development has also been going forward. The most recent important line to be opened is that of 163 kilometers between Manakara and Fianarantsoa, opened the first of April, 1936.[58] A series of maps showing the progress of transportation in 1895, 1925, 1930, and 1933 has been prepared by L. Coursin.[59]

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[48] Raymond Decary: La conquête économique de l'extrême-sud de Madagascar, *La Géographie*, Paris, Vol. 64, 1935, pp. 365–376.

[49] M. Reynier: L'aménagement agricole des eaux prévu au programme des grands travaux . . . à Madagascar, *L'Agric Pratique des Pays Chauds*, Paris, Nos. 19 and 21 (N.S.), 1932, pp. 3–14 and 217–229.

[50] E. François: La production du ricin: à Madagascar, *Rev. de Botanique Appliquée et d'Agric Tropicale*, Vol. 14, 1934, pp. 930–938; Raymond Decary: Le ricin dans l'extrême sud de Madagascar, *ibid.*, pp. 1035–1037.

[51] Coup d'oeil sur Madagascar, *L'Illustration*, No. 4895, Vol. 94, Dec. 26, 1936, suppl., pp. xiii–xv. Many studies on individual products are available in recent numbers of *La Rev. de Madagascar* and *L'Agronomie Coloniale*.

[52] G. Petit: L'industries des pêches à Madagascar (Bibliothèque de la faune des colonies françaises), Paris, 1930.

[53] A. Bruggeman: Tananarive, son passé, son évolution, son avenir, *La Vie Urbaine*, Vol. 10, 1933, pp. 1–32 and 69–112; Robert Boudry: Les villes malgaches—Tananarive, *La Rev. de Madagascar*, Tananarive, No. 3, July, 1933, pp. 55–112.

[54] Une grande métropole coloniale: Tananarive, *L'Illustration*, No. 4895, Vol. 94, Dec. 26, 1936, p. 529.

[55] M. A. Leblond: Les villes malgaches—Tamatave, *La Rev. de Madagascar*, Tananarive, No. 4, Oct., 1933, pp. 93–125; Hubert Deschamps: Tamatave, porte de l'est, *ibid.*, No. 14, Apr., 1936, pp. 133–152.

[56] G. and A. Cassaigne: Antsirabé, Vichy de l'Océan Indien, *La Vie Urbaine*, Vol. 11, 1934, pp. 174–182.

[57] Léon Réallon: Madagascar: A French Province, *Asiatic Rev.*, Vol. 30 (N.S.), 1934, pp. 580–585; reference on p. 585.

[58] *L'Illustration*, No. 4895, Vol. 94, Dec. 26, 1936, suppl. p. xiii.

[59] L. Coursin: Le réseau routier de Madagascar, *La Rev. de Madagascar*, Tananarive, No. 6, Apr., 1934, pp. 27–61.

THIRTY-THIRD ANNUAL MEETING OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE Association of American Geographers held its thirty-third annual meeting at Syracuse on December 31, 1936, and January 1 and 2, 1937, under the presidency of Professor William H. Hobbs of the University of Michigan. With the exception of an evening round-table conference in Hendricks Chapel of Syracuse University, the sessions were held in the ball room of the Onondaga Hotel. In neighboring rooms map exhibits were on display illustrating recent work of members, map publishers, and others. Professor G. B. Cressey of Syracuse University and his associates on the local committee deserve much credit for the efficient arrangements made for the conduct of the meetings. On New Year's Day a short field excursion through the environs of the city was conducted by Professor E. H. Faigle of Syracuse University; among other points of interest, old salt workings and the Barge Canal were visited.

The following officers were elected for 1937: W. L. G. Joerg, president; Guy-Harold Smith, vice-president; John E. Orchard, treasurer; Preston E. James, secretary; and Richard Hartshorne, councilor for three years. Other members of the Council for 1937 are C. C. Colby, W. H. Hobbs, Kirk Bryan, and R. J. Russell. Derwent Whittlesey continues as editor of the *Annals*. The next meeting will be held at Ann Arbor, Michigan.

Including the presidential address, 45 papers were actually read at open sessions; 21 of these were by introduced speakers. Papers dealing with related topics or regions, whether by members or introduced, were grouped together so far as possible, and there was ample time for discussion of most of the papers.

At the annual banquet, after a gracious address of welcome by Acting Chancellor W. P. Graham of Syracuse University, Professor Hobbs announced two gifts to the Association. The first is a fund donated by President W. W. Atwood of Clark University. Out of the principal an award has been made to R. J. Russell for work in the Volga Delta region during the summer of 1937; the accumulated income from the remainder will be granted from time to time in aid of field studies in physical geography. The other gift will take the form of royalties on the sales of a volume entitled "Our Natural Resources and Their Conservation," a coöperative work by 22 American geographers recently published under the editorship of A. E. Parkins and J. R. Whitaker. The authors have generously agreed to donate the royalties equally to the Association of American Geographers and the National Council of Geography Teachers for the promotion of geographical research.

Polar Exploration

Polar exploration was the subject of the presidential address, delivered at the annual banquet, and also of a special session arranged by Professor Hobbs.

In his presidential address, "Discovery and Exploration within the Arctic Region," Professor Hobbs surveyed the whole field of Arctic exploration from the time of Pytheas of Massilia to the present. He gave a concise account of the principal achievements of each of the maritime voyages and overland journeys that have contributed materially to the widening of geographical knowledge.

At the special session the most comprehensive paper was that of W. L. G. Joerg: a summary of the advance of geographical knowledge of the Antarctic during the last decade. Attention was directed not only to the work of formally organized exploring expeditions but also to the productive scientific researches of the Norwegian whalers. Professor Hobbs read a paper by Sir Hubert Wilkins entitled "Some Polar Problems and the Methods by Which They May Be Solved," in

which the need of international coöperation was stressed and two chief problems were suggested: the possibility of a strait connecting Ross Sea and Weddell Sea and the question of unknown land in the Arctic between the routes of Amundsen's and Ellsworth's transpolar flight and of Wilkins' flight from Point Barrow to Spitsbergen. L. M. Gould (introduced), second-in-command on Byrd's first Antarctic expedition, discussed the geomorphology and glacial features of the Queen Maud Mountains (see *Geogr. Rev.*, Vol. 31, 1931, pp. 177–200), and T. C. Poulter (introduced), second-in-command on the second expedition, described the seismic apparatus and techniques employed during that expedition to measure the depth of ice and thereby to prove or disprove the existence of ice-buried land areas. O. M. Miller dealt with the problem of preparing maps from high oblique photographs taken during flights in the polar regions. He specified certain essential observations that must be made if such photographs are to be of cartographic value, referring also to methods and instruments that he has developed at the American Geographical Society. Professor Hobbs described the effect of polar mirage or "looming." This phenomenon, combined with the clarity of the air, has occasionally led explorers to underestimate distances and thereby to show coasts and islands in erroneous positions upon their maps.

The Geography of Soils

At a special session on soils, arranged by W. E. Ekblaw, four papers were presented, three of a broadly philosophical nature and one dealing with the soils of a particular region. In the last J. S. Gibson (introduced) considered the problem of the primary classification of the soils of the Tennessee Valley.

Professor Ekblaw, in discussing "The Significance of Soils Geography," pointed out that the character of the soils tends to reflect the aggregate of the contemporary natural elements existing in a region; for this reason soils furnish what are perhaps the most satisfactory single criterion for a preliminary classification of regional phenomena. J. O. Veatch ("The Geographic Significance of the Soil Type") dealt more especially with the classification of soils into types and larger groupings; he emphasized the importance of a detailed knowledge of soils and soil maps as a basis for land inventories, the study of land-use patterns, and the delineation of natural land divisions. C. E. Kellogg (introduced), who is the late Dr. C. F. Marbut's successor as chief of the Soil Survey Division, U. S. Department of Agriculture, pointed to the soil as reflecting the sum total of the biological and geological elements in a region. He expressed a firm conviction that the conservation of the soil and the preservation of the freedom of agriculture from urban dominance are among the most pressing issues facing society today.

Soil erosion in Virginia before the Civil War was the subject of a paper read by A. R. Hall (introduced) at one of the regular sessions. Writings of the period give ample evidence that soil erosion constituted a serious menace at an earlier date than is commonly supposed to be the case.

Areal and Urban Studies

Of the papers dealing primarily with particular areas and regions, those that aroused the greatest general interest were based upon recent field studies carried out by members of the Association in the Far East, South America, Africa, and Europe. In a skillful combination of the results of historical research and field work, R. B. Hall ("The Tokaido—Road and Region") showed the part played in Japan's development by the great historic highway connecting Tokyo and Kyoto, a road that has today been largely supplanted by a railway. G. B. Cressey contrasted two Chinese cities and their immediate environs: Tungchow, just east of Peiping and typical of the north with its relatively dry climate, and Shatin, near

Victoria (Hong Kong), in the rainier, monsoonal south. G. T. Trewartha presented the results of field observations in a part of the Canton Delta where silk culture prevails. A journey, largely by air, from the east coast of Brazil, up the Amazon, and across the Andes to Peru provided R. S. Platt with an opportunity of investigating, among many other things, the fishing communities of the coasts and rivers. Some of these he described in a delightfully informal paper illustrated by superb photographs. Kano, an old city and trading center of the Nigerian Sudan, was interpreted by Derwent Whittlesey, who signalized the rapid changes that have occurred in the aspect of the town and in its economic relationships since the establishment of British rule (see this number of the *Geographical Review*, pp. 177–199).

Four papers (besides one by Professor Van Valkenburg and Margaret Quimby mentioned below under the heading "Political Geography") dealt with European topics. H. M. Leppard described "The Water Gates of the Narrow Seas," by which was meant the rivers and estuaries entering the English Channel, the North Sea, the Irish Sea, and the Baltic. Some of the effects upon tidal action of shoreline trends and the relationship of these factors to the growth of ports were indicated. H. S. Kemp (introduced) commented upon areas of production and culture in Spain in connection with the present civil war and illustrated some of his points with the aid of a novel cartographic device. To his earlier studies of the islands off the west coast of Ireland (see, for example, *Geogr. Rev.*, Vol. 17, pp. 387–396; Vol. 25, pp. 618–624), L. E. Klimm added observations on the problem of fuel supply; on some of the islands the stripping of the peat or turf for burning has seriously reduced the limited areas of arable and pasture land. E. A. Ackerman (introduced) contrasted the granitic Limousin and the limestone Causses regions of the Central Massif of France with respect to historical, economic, and social circumstances.

In several papers areas of relatively small extent in North America were described and interpreted. J. R. Randall (introduced) described patterns of settlement in the Great Clay Belt of northern Ontario and Quebec. D. I. Blumenstock (introduced) discussed certain correlations between geography and primitive culture in the southern Sierra Nevada, and C. M. Davis (introduced) presented the results of a study of land utilization in North Park, Colorado. G. D. Hubbard spoke on a recent trip down the Gaspé Peninsula, and L. S. Wilson (introduced) described the geographical setting of Coöperative, in southeastern Kentucky, a community developed by a coal and lumber company and dependent on subsistence farming combined with mining and lumber operations. How the problem of flood control is being solved in the Muskingum watershed, Ohio, was explained by C. C. Huntington (introduced).

That linguistic researches have something to offer the geographer was suggested in an introduced paper by Professor Hans Kurath, who is in charge of the work on the "Linguistic Atlas of the United States and Canada" (see *Geogr. Rev.*, Vol. 21, 1931, pp. 483–486). Professor Kurath presented linguistic evidence that throws light upon the routes taken and areas occupied by early settlers in New England and Virginia.

Four papers had to do with cities in the United States. With the aid of careful maps H. T. Straw (introduced) explained the functional areas of Battle Creek, Michigan; he asserted that cereal processing, though popularly believed to be the dominant industry, is actually of minor importance. E. H. Faigle (introduced) sketched the growth of Syracuse in relation to situation and site and illustrated with maps and photographs functional areas into which the city may be divided. The positions of the waterworks intakes of some of the larger cities on the Great Lakes in relation to river mouths and longshore currents were described by Bert Hudgins (introduced). M. J. Proudfoot (introduced) of the Bureau of the Census considered the problem of the census analysis of intra-city business areas; he suggested that a subdivision into districts of five different types would appear to be appropriate

to most American cities: "central business," "outlying business," "principal business thoroughfare," "neighborhood business," and "isolated store clusters."

A somewhat analogous problem of census analysis was discussed by C. E. Batschelet, Geographer of the Bureau of the Census. There are many unincorporated villages in the United States for which the Census has hitherto published no separate data. Some of these are as large and important as incorporated centers. Methods and criteria are being developed for defining and delimiting such settlements, but further refinements are needed.

Political Geography

Problems in political geography were considered in three papers. S. W. Boggs ("Notes on Certain Problems in the Definition of Water Boundaries") explained difficulties that have arisen in the interpretation of terms used in negotiations and treaties with respect to water boundaries and gave an effective demonstration of possible methods of solving such problems. C. L. Stotz (introduced) outlined the larger politico-geographical problems of Turkey today. Professor Samuel Van Valkenburg read a paper by himself and Margaret Quimby (introduced) on the regional and political geography of Eupen and Malmédy, territories transferred from Germany to Belgium by the Treaty of Versailles. The belief was expressed that although there are many strong geographical and economic ties with Belgium, the regions are more closely allied to Germany in national sentiment.

Geomorphology

At the St. Louis meeting of the Association in 1935–1936 six papers dealt with geomorphology. At Syracuse the results of only three independent studies in this basic field were presented. If the tendency shown by these figures arouses regret, it is to be hoped that President Atwood's generous grant for field work in physical geography may help restore a more even balance.

Reference has been made to Professor Gould's paper on the geomorphology of the Queen Maud Mountains.

W. W. Atwood outlined some of the results of many seasons of field work that he and his son have carried out in the Rocky Mountains; he made the suggestion that several apparent peneplain surfaces may have been produced during one cycle of erosion. W. W. Atwood, Jr. discussed these matters in greater detail and spoke more particularly of the courses and origin of "superimposed" streams that have carved several remarkable canyons in the region. R. J. Russell in a report on the loess of the Lower Mississippi region set forth evidence that seems to prove that this material is not of eolian origin but is, rather, alluvial silt. Professor Russell's paper aroused discussion, in the course of which the question was asked whether the term "loess" could properly be applied to deposits of this type.

Climatic Studies

Three papers had to do with climate. C. F. Brooks described the meteorological circumstances that have brought about recent floods in the Ohio Valley (see this number of the *Geographical Review*, pp. 270–290). A. K. Botts (introduced) outlined the results of an investigation of rainfall in the middle west in 1935 and 1936 in relation to the predominance of certain air masses; these studies offer a possible clue to the understanding of droughts. C. W. Thornthwaite's paper, "The Life History of Rainstorms in Oklahoma," was published in the January, 1937, number of the *Geographical Review*. It marks the introduction of a new technique in climatological and meteorological analysis, one that will undoubtedly have scientific and practical consequences of high value, and it is to be hoped that means may be found for carrying out similar studies in other regions.

Miscellaneous Papers

Three papers dealt with topics that cannot properly be classified under any of the preceding headings. Ellsworth Huntington's discussion of "Season of Birth and the Distribution of Civilization" evoked animated discussion. Professor Huntington upheld the thesis, supporting his conclusions by graphs and maps, that people conceived and born at certain times of the year have a greater chance of living long and attaining eminence than those born at other times. Furthermore, conceptions and births reach their peaks at different seasons in different parts of the world, as a result, perhaps, of more or less direct climatic influences. Erwin Raisz (introduced) showed and explained certain ingenious charts that he has prepared illustrating the history of cartography. J. K. Wright described a technique for measuring and expressing in quantitative terms the degree of evenness or unevenness of the distribution of geographical phenomena.

Round-Table Discussion of the Cultural Geography of North America

On the evening of December 31 a round table on the Cultural Geography of North America, open only to members of the Association, was held under the leadership of S. D. Dodge. Attention was focused in the first instance upon: the Rocky Mountains (W. W. Atwood), the Great Plains (R. H. Brown), the lower Mississippi (F. B. Kniffen), the Great Lakes (R. B. Hall), and New England (Derwent Whittlesey). In regard to each of these regions the geographers named opened the discussion and were followed by others. The speakers explained what they believe to be fruitful avenues for future research to follow. A few of the larger ideas and questions that emerged from the discussion may be stated. As to the importance of the historical as well as of the "field" approach there would appear to be general agreement; the view was also emphasized that the geographer need concern himself little with events and conditions in the past that have not left a pronounced mark upon the present. There seems, however, to be little agreement as to what is meant by "cultural geography" and how the study of this subject should be pursued. "Culturogeographical areas" (a term suggested by F. B. Kniffen) should doubtless be marked out and perhaps classified, but how? It is questionable whether schemes of classification anything like those adapted to biological or climatic phenomena may be devised or properly employed. Can detailed field studies be so directed and their results so presented that they will fit into a larger framework of synthesis and serve as a basis for valid comparisons and sound generalizations? Should cultural studies be concerned with observable, material facts only, or should the intangibles be considered? In regard to all these matters it is evident that American geographers are healthily at variance in their views.

AMERICAN GEOGRAPHICAL SOCIETY

The December Meeting. The regular monthly meeting of the American Geographical Society was held on December 22, 1936, at the Engineering Societies' Building, 29 West 39th Street, Mr. Henry, Chairman of the Council, presiding. Dr. H. L. Shapiro, Associate Curator of Physical Anthropology at the American Museum of Natural History, delivered a lecture entitled "Pitcairn: Heritage of the Bounty." Dr. Shapiro spent six months in 1923 and 1924 among the descendants of the mutineers of the *Bounty* now settled on Norfolk Island. In 1934 and 1935, as a member of an expedition conducted for the American Museum of Natural History by Mr. Templeton Crocker, he had an opportunity to spend ten days on Pitcairn Island, the original refuge of the mutineers. His lecture, illustrated with slides and motion pictures, dealt with the history and present-day life of the descendants of the mutineers and their Tahitian wives from the anthropologist's point of view.

The January Meeting. The Annual Meeting of the Society was held on January 26, 1937, at the Engineering Societies' Building, 29 West 39th Street, Mr. Henry presiding. After a brief summary of the Annual Report (printed below) and the election of Officers and Councilors for 1937, Major Leonard Handley delivered a lecture entitled "Pirates and Pearls down the Malabar Coast." Major Handley was for some twenty years an officer in the Light Horse Cavalry of the Indian Army and during this period and since his retirement has traveled widely in the East. He spent the past two years on the Malabar Coast of India making motion pictures of the remains of the early Portuguese settlements, present-day life and industries along the coast, and the topography of the interior.

The February Meeting. The regular monthly meeting of the Society was held on February 23, 1937, at the Engineering Societies' Building, 29 West 39th Street, Mr. Henry presiding. Mme. Hettie Dyhrenfurth of Zürich delivered a lecture entitled "The Conquest of Queen Mary Peak." Mme. Dyhrenfurth has been a member of two International Himalayan Expeditions conducted by her husband, Dr. Gunther O. Dyhrenfurth. On the 1934 expedition she established a new world's altitude record for women in her ascent of Queen Mary Peak. In her lecture, illustrated by lantern slides and motion pictures, she gave an intimate story of the expedition from the point of view of the service of supply, of which she had charge.

The Louise A. Boyd Arctic Expedition of 1937. Miss Louise A. Boyd, who has financed and conducted a number of expeditions into the Arctic in recent years, is planning another expedition during the summer of 1937. It will be recalled that in 1933 Miss Boyd led an expedition to East Greenland for the study of glacial marginal features in the region of the Franz Josef and King Oscar Fiords, the results of which were published by the Society in "The Fiord Region of East Greenland."

Miss Boyd has again charted the Norwegian sealing vessel, the *Veslekari*, which she equipped with a sonic depth finder for her 1933 expedition, and plans to spend about a month on sounding work in the sea between Spitsbergen and Greenland with the particular objective of exploring the sea floor as far northwestward from Spitsbergen as ice conditions will permit. After the completion of the sounding work the ship will return to Norway to pick up the rest of the party and proceed to East Greenland, stopping for a few days' study of glaciers on Jan Mayen Island. In East Greenland further geomorphological, ecological, and survey work will be done. Tide gauges will also be set up for records at various critical points. Miss Boyd, who is an expert on Arctic photography, will do the photographic work of the expedition as she has on all her previous expeditions. The scientific staff accompanying her

will consist of a geomorphologist and his assistant, an ecologist, a hydrographer to handle the sounding and tide-gauge work, and a surveyor. As in the case of Miss Boyd's expedition of 1933, the Society is sponsoring the scientific objectives of the expedition and is assisting with plans and arrangements.

The "Bibliographie Géographique Internationale" for 1935. The forty-fifth issue of the *Bibliographie Géographique Internationale* is now ready for distribution in the United States by the American Geographical Society. It is published by the Association de Géographes Français with the collaboration of the American Geographical Society, the Comitato Geografico Nazionale Italiano, the Geographische Gesellschaft in Wien, the Royal Geographical Society (London), the Société Belge d'Études Géographiques, and the Société Royale de Géographie d'Égypte. The material is critically selected, and brief notes or references to reviews in outstanding geographical periodicals are added to many of the titles. Current publications—books, periodicals, government and state publications, and maps—are included.

Resignation of Mr. W. L. G. Joerg from the Staff. The Council of the Society at its meeting on January 21, 1937, voted to accept with regret the resignation of Mr. W. L. G. Joerg from the Society's staff. In April Mr. Joerg assumes the position of Chief of the Division of Maps and Charts of The National Archives in Washington.

Mr. Joerg joined the Society's staff in 1911 as assistant editor of the *Bulletin of the American Geographical Society*. In 1916, when the *Bulletin* was superseded by the *Geographical Review*, he was appointed associate editor and served in that capacity until 1920, when he became editor of the Society's monographic publications known as the *Research Series*. Since 1926 he has had the title of Research Editor.

As a scholar Mr. Joerg has achieved an international reputation. Few Americans have a broader or more understanding knowledge of the development of geography and of current movements in the field both in the United States and abroad. His scholarship has borne ripe fruit in several critical studies of the progress and status of geographical research. Most of his outstanding original contributions have been published by the American Geographical Society, many of them in the *Geographical Review*. The comprehensive "Recent Geographical Work in Europe" (*Geogr. Rev.*, Vol. 12, 1922, pp. 431–484) was based upon examination of the significant books and articles of contemporary geographers supplemented by notes made during an extended journey through Europe. In "Geography and National Land Planning" (*ibid.*, Vol. 25, 1935, pp. 177–208) the activities and recommendations of various agencies recently established by the government in connection with land use and land planning are discussed. Mr. Joerg has had charge of the Society's program of polar research for a number of years, and he is well known as an authority on Arctic and Antarctic exploration and cartography. In this field, besides editing several publications of the Society, he has contributed a small volume of his own: "Brief History of Polar Exploration since the Introduction of Flying" (1930). This work forms a part of the Society's *Special Publication No. 11*, which contains, in addition, a physical map of the Arctic and a fundamental bathymetric map of the Antarctic, both on the scale of 1 : 20,000,000. The latter was compiled under Mr. Joerg's direction and from the original sources. Mr. Joerg is frequently consulted as one of the leading American experts on maps and cartographic techniques. The maps appearing in the "Chronicles of America" series, published by the Yale University Press, were prepared by him; and he is the author of several papers dealing with maps and allied topics, notably "On the Proper Map for Determining the Location of Earthquakes" (*Annals Assn. of Amer. Geogrs.*, Vol. 2, 1912, pp. 49–54), "Post-War Atlases: A Review" (*Geogr. Rev.*, Vol. 13, 1923, pp. 583–598), "Recent American Wall Maps: A Review" (*ibid.*, Vol. 14, 1924, pp. 456–464), and "The Development of Polish Cartography since the World War" (*ibid.*, Vol. 23, 1933, pp. 122–129). Since 1913

he has contributed an annual report on the progress of cartography to the *American Year Book*.

Mr. Joerg has made the regional geography of North America one of his special fields. His first important paper dealt with "The Tectonic Lines of the Northern Part of the North American Cordillera" (*Bull. Amer. Geogr. Soc.*, Vol. 42, 1910, pp. 161–179). This was followed in 1914 by an explanation and comparison of various methods that had previously been proposed for "The Subdivision of North America into Natural Regions: A Preliminary Inquiry" (*Annals Assn. of Amer. Geogrs.*, Vol. 4, 1914, pp. 55–83). In his latest study, "The Geography of North America: A History of Its Regional Exposition" (*Geogr. Rev.*, Vol. 36, 1936, pp. 640–663), he introduces a review of Henri Baulig's "Amérique septentrionale" (Paris, 2 vols., 1935–1936) with a concise analytical survey of the history of the regional geographies of North America that appeared during the period 1877–1934.

The improvement and refinement that Mr. Joerg has effected in the materials that have passed through his hands as editor have won for him the lasting gratitude of their authors and the appreciation of all discriminating readers. Exclusive of pamphlets he has edited the following works published by the Society: *Research Series*: (Nos. 1 and 2) "Bering's Voyages," by F. A. Golder, 2 vols., 1922, 1925; (3) "Battlefields of the World War," by Douglas Johnson, 1921; (8) "Legendary Islands of the Atlantic," by W. H. Babcock, 1922; (9) "A Catalogue of Geological Maps of South America," by H. B. Sullivan, 1922; (10) "Aids to Geographical Research," by J. K. Wright; (11) "The Recession of the Last Ice Sheet in New England," by Ernst Antevs, 1922; (12) "The Land Systems of Mexico," by G. M. McBride, 1923; (13) "The Vegetation and Soils of Africa," by H. L. Shantz and C. F. Marbut, 1923; (14) "The Geographical Conceptions of Columbus," by G. E. Nunn, 1924; (15) "The Geographical Lore of the Time of the Crusades," by J. K. Wright; (16) "Peopling the Argentine Pampa," by Mark Jefferson, 1926; *Special Publications*: [No. 1] "Memorial Volume of the Transcontinental Excursion of 1912 of the American Geographical Society of New York," 1915; (7) "Problems of Polar Research," by 31 authors, 1928; (8) "The Geography of the Polar Regions," by Otto Nordenskjöld and Ludwig Mecking, 1928; (14) "Pioneer Settlement," by 26 authors, 1932; (17) "The Discovery of the Amazon According to the Account of Friar Gaspar de Carvajal and Other Documents," 1934. He is also joint editor with Professor W. A. Mackintosh of the nine-volume "Canadian Frontiers of Settlement," in course of publication by the Canadian Pioneer Problems Committee. This work is a development of the Society's program of pioneer studies initiated by the former director, Dr. Isaiah Bowman.

In addition to his regular activities at the Society, Mr. Joerg has served as representative of the Society in many organizations of national and international importance. He represented the Society for a number of years in the Division of Geology and Geography of the National Research Council and has recently been vice chairman of the Division and a member of the Executive Committee of the Council. He has served as councilor and vice president of the Association of American Geographers and is its president for the current year. As a result of his work in the field of pioneer settlement he was engaged in 1933 by the Science Advisory Board for a two-year period to assist in research in connection with the report of this Board on "Land Resource and Land Use in Relation to Public Policy." The report, prepared by Professor C. O. Sauer, was edited by him.

The Division of Maps and Charts of The National Archives, to the direction of which Mr. Joerg has been appointed, is one of a number of divisions through which the professional and technical work of that institution is carried out. The National Archives was established by act of Congress in June, 1934, to preserve those records of the Federal Government that have permanent administrative or historical value and make them available for use in the business of the government and in the service

of scholarship. At the head of the institution is the Archivist of the United States, Dr. R. D. W. Connor, late Kenan Professor of American History and Government at the University of North Carolina. As one of the first tasks undertaken by the Archives, surveys have been made of the material in the government agencies and establishments in Washington and throughout the country, including the map material in such agencies as the Geological Survey, the Coast and Geodetic Survey, the General Land Office, and the Corps of Engineers, the last including some of the early exploratory surveys in the West. Appraisal of this body of material, recommendation as to what portions are deemed worthy of preservation, organization of the preserved material with a view to making it accessible, and scientific research on it come under the jurisdiction of the Division of Maps and Charts.

Staff Appointments. Dr. John K. Wright, Librarian of the Society since 1920, has been appointed to the position of Research Editor; Miss Elizabeth T. Platt, Assistant Librarian since 1925, succeeds Dr. Wright as Librarian.

ANNUAL REPORT OF THE COUNCIL

January 26, 1937

To the Fellows of the Society:

There is a steadily growing tendency to scrutinize the work of scientific institutions from the standpoint of their actual services to the public. Public service was clearly the objective of the public-spirited men who organized the Society eighty-five years ago "for the purpose of collecting and diffusing geographical and statistical information." In pursuit of this objective not only has there been assembled at the Society a collection of books, periodicals, and maps that is one of the world's most important collections of geographical publications, but constant effort is made to make this material easily available to the consulting public through the development of special cataloguing devices and the maintenance of a library staff expert in the handling of geographical source materials.

The advantages of such a collection of source material kept constantly up to date and organized for easy access to all its parts are many. In preparing replies to the inquiries that come daily to the library by telephone, letter, and personal call, the library staff has immediate access to the resources of the collection. The requests for special bibliographies and other guides to research can be supplied with a minimum of time and effort. Research workers consulting the collections find much of the preliminary searching for material already done for them. Finally, the members of the staff of the Society are assured of having directed to their attention all of the material in the collections pertinent to any piece of research or editorial work on which they may be engaged.

In pursuance of another of the purposes of the founders of the Society—"the advancement of geographical science"—it will be seen from the following summary that in its selection of articles for the *Geographical Review*, in its book and map publications, in its associations with other scientific institutions, and in its recognition of achievement in geography by awards of medals and honors, the Society is following a well organized program.

The Geographical Review

It is the constant editorial policy of the *Geographical Review* to give its readers the advantage of the variety that makes the rare spice of geography, and the Society is as favorably situated to do so as that "happy man who was content with his own town, his continent." One of the articles in the volume just completed deals with the diversity of New York City, and we may select the report on the Wood

Yukon Expedition of 1935 as representing the other end of the wide range of geographical problems offered by our own continent. Both articles are by members of the Society's own staff: the former is especially interesting for its graphic presentation, the latter for its fine aerial photographs, which will be used for the construction of a topographic map by the photogrammetrical method developed in the Society's Department of Technical Training. This method is now being used for the Society's map of northern Labrador, the first (Cape Chidley) sheet of which was published last January, accompanying Dr. Alexander Forbes' report on his 1935 flight to Cape Chidley. The land on the opposite shores of Hudson Strait also figures in the 1936 volume of the *Geographical Review* in the exploration of the Lake Harbour region, southern Baffin Island, by a naturalist of Canada's Department of the Interior. By way of contrast there are studies of intensive agriculture in California—fruit orcharding in the Santa Clara Valley and market gardening on the Palos Verdes Hills—and an article on the Jackson Hole country of Wyoming, a difficult if not submarginal area, that offers delicate problems to the regional planner.

There is no need to dwell on the importance of a study of types and distribution of fog in the United States carried out on modern meteorological lines by a member of the Blue Hill Observatory staff. We may, however, take occasion to point out the increasing use of the statistical method in geography as exemplified in an inquiry into the relation between corn yield and climate in the corn belt and in a new approach to the study of the rainfall regime of the Western Plains. A new classification of flood-plain streams is presented with North American examples, and a new quantitative analysis of stream (arroyo) meandering is essayed. We preserve, also, a record of the famous submerged forest of the Columbia River Gorge soon to be lost in the Columbia River Development. Our North American studies conclude with a critical review of the regional exposition of the geography of our continent.

In "The Lakes of Potosí" we find geography in its most romantic aspects. Mr. W. E. Rudolph tells of his reconstruction of the early colonial water-supply system devised to meet the needs of the vast silver production that had such momentous consequences for Spain and the rest of the western world. Attention is also concentrated on modern Spain, on which we have published two articles: one deals with the fundamental agrarian problems of the country as a whole, the other is a regional picture of that little-known corner, Galicia. In "A View from Canigou: Nature and Man in the Eastern Pyrenees," an eminent French botanist, while adorning our pages with his delightful tale, points a moral for conservation. We also note a presentation of the "Vegetation Zones in the Caucasus," by an American botanist, and Miss Louise A. Boyd's pictorial commentary on life in the Pińsk marshes, a chapter from her book "Polish Countrysides."

With the question of colonial Africa looming large, an article on Tanganyika Territory finds a receptive audience. In the discussion of his distribution map of the native population the author, Mr. Clement Gillman, chief engineer of the Tanganyika Railways, is concerned not with the political situation but with matters germane to all programs of settlement and development in tropical Africa. Related to this theme is a review of recent literature on the impact of western civilization on Negro Africa, while at the other end of the geographical range is a review of the problem of early man and his environment in the Nile Valley, a survey of the field studies of the Oriental Institute of the University of Chicago.

Four contributions deal with China—a discussion of her monetary situation and its relation to the silver market, an article on the origin and growth of Shanghai, an intimate picture of day-by-day life in a near-by countryside of the Yangtze Delta with its antique human pattern, a study of the loess soils of Shansi from the agricultural point of view. From Australia comes a description of its remarkable sand-ridge deserts by the geologist who pioneered the use of the airplane for professional

purposes in his country. Lastly, we have a preliminary discussion of the topographical results of Lincoln Ellsworth's trans-Antarctic flight of 1935 accompanied by a selection of the most significant photographs taken on the flight.

New Books

During the year editorial work was completed on a book entitled "Polish Countrysides," by Louise A. Boyd, which was published in January, 1937. In this volume are reproduced 484 photographs of Polish rural life selected from some 2500 taken by Miss Boyd during an automobile journey of 6300 miles made in 1934. The photographs are arranged by topics and are accompanied by a narrative of her journey written by Miss Boyd and an article by Dr. Stanisław Gorzuchowski, a Polish geographer.

Editorial work was also completed on a volume on "The Frame of the Ancient Greek Maps," by Professor William A. Heidel of Wesleyan University, which will be published this year. In this book the author presents the results of many years of research on the character of the early Greek maps of which no examples have come down to us but which are known to have existed from the many references to them in the literature of the time.

During the year the Society published the second decennial index to the *Geographical Review*. This is an analytical guide to the contents of Volumes 16 to 25 (1926–1935), compiled by Arthur A. Brooks. The first ten-year index was published in 1926. The two indexes are the chronological successors to the "Index to the Bulletin of the American Geographical Society, 1852–1915," published in 1918.

Department of Hispanic American Research

A total of 65 sheets of the Map of Hispanic America has now been published. The remaining sheets are ready for the lithographers and are being sent to them as rapidly as they are able to handle them. On account of the great amount of handwork required to prepare the plates for the printing of the hypsometric tints, the lithographers' work has been proceeding more slowly than was anticipated, but it is expected that the entire map of 102 sheets will be ready for distribution in 1938.

Department of Technical Training

This department continued during the year its service as a bureau of technical information and advice on methods of survey and map construction. The number of requests for this service is steadily increasing. Surveying instruments were loaned to six field parties, and the department acquired by gift a chronograph, available on loan for field work in which precise time recording is required.

A member of the staff of the department was given a short leave of absence to establish by astronomical determinations a geographical position in South America of importance in connection with the delineation of concession boundaries. During the summer Mr. Walter A. Wood, Jr., a member of the staff, carried out his second expedition to the Yukon under the auspices of the Society. The principal purpose of this expedition and that of the preceding summer was to do further experimental work on the method of mapping by oblique aerial photographs developed at the Society. On the two expeditions ground control was established, and some 4000 square miles of a hitherto unmapped section of the St. Elias Range were photographed.

The first sheet of the map of northern Labrador that is being constructed from high oblique photographs taken under the Society's direction on the Grenfell-Forbes expedition of 1931 and the Forbes expedition of 1935 was published in the January issue of the *Geographical Review*. The sheet is on the scale of 1:100,000 with con-

tours at 50-meter intervals. Two more sheets, covering more than 1000 square miles were completed during the year. Meanwhile, improved techniques have been developed, which greatly increase the speed and accuracy of the work. This method has also made possible the plotting of topographical detail from photographs taken on the Ellsworth Trans-Antarctic Expedition.

The program of research in photogrammetrical mapping that is being carried on by the department continues to attract attention. The single-eyepiece plotting instrument constructed on a new optical principle developed by the head of the department has proved completely successful and is in constant use in connection with the construction of the map of northern Labrador. Preliminary scale assembly drawings and specifications have been completed for a stereoscopic plotting instrument involving this same optical principle, and efforts are now being made to secure funds for manufacturing the first model.

Library and Map Collections

During the year 567 books, 452 pamphlets, 974 volumes of periodicals, 2726 maps, 46 atlases, and 3854 photographs were added to the Society's collections. The collections now consist of 103,572 volumes of books and periodicals, 18,347 pamphlets, 94,227 maps, 1861 atlases, 14,030 photographs, and 1534 lantern slides.

A gift to the library of special importance was made by Mr. Rudolf Cronau, well known authority and writer on the voyages of Columbus. It consists of books, maps, photographs, pamphlets, newspaper clippings, and some manuscript material (the latter including the donor's journal of his travels in the Bahamas and the West Indies in 1890–1891 in connection with his study of Columbus's landfall) assembled during his many years of research and travel. Other gifts to the library include: Baedeker's "Paris," 1872, Baedeker's "Northern Germany," 1877, Black's "Guide to the Trossachs," 1860, and Bradshaw's "Continental Railways," 1854, from Mrs. M. S. Düring; 149 House and River and Harbor Committee Documents from the U. S. War Department; "U. S. 30th Congress First Session Senate. Miscellaneous Document, 1848," from Miss Emily G. Balch; Davies' "The Dorset Coast," 1935, and Yates' "Hampton Court," 1935, from Miss Mary S. Johnston; G. O. Dyhrenfurth's "Dämon Himalaya," 1935, and Hettie Dyhrenfurth's "Memsahb im Himalaja," 1931, from Mrs. Dyhrenfurth; Neri Fernandez's "Geografía de America Central," 1926, from Dr. C. E. McGuire; from Gerardo Castellanos y Garcia, his "Motivos de Cayo Hueso," 1935, and "Panorama Histórico," 1934, and González y Contreras' "Don Gerardo," 1935; "El Arte Peruano en la Escuela" n.d., and Cossio del Pomar's "Pintura Colonial," 1928, from Señorita Elena Izcue; Martinez Vela's "Anales de Potosí, Tome 1," 1925, and Subieta Sagarnaga's "Potosí Antiguo y Moderno: I Entrega," 1928, from Mr. W. E. Rudolph; "Libros de Cabildos de Lima," 2 vols., 1935, from the Biblioteca Municipal de Lima; E. Licent's "Comptes-Rendus de Onze Années, 1923–1933, . . . dans le Bassin du Fleuve Jaune," 2 vols. and atlas, 1935–36, from The French Bookstore, Peiping; "Nel Cinquantenario della Società Edison, 1884–1934," 4 vols., 1934, from the Società Edison.

In addition to surveys, geological maps, and charts from government bureaus of many countries, the Map Department received as gifts: 6 topographic maps of Northern Rhodesia from the Aircraft Operating Company of South Africa; 2 photostats of early maps of America from Mr. A. B. Andrews; 1 general atlas from John Bartholomew and Son, Ltd.; "Plan of Jerusalem," 1865, from Mrs. Banyer Clarkson; Stieler's "Schul-Atlas," 1842, from Mrs. M. S. Düring; 2 general atlases and 11 maps from G. Freytag and Berndt; 5 school maps and 3 school atlases from George Gill, Ltd.; 1 map of Grand Manan Island from G. C. Harrap, Ltd.; 1 atlas of the Antarctic from Hvalfangernes Assuranceforening; "Atlas de la République Tchécoslovaque," from the Institut de Géographie, Charles IV University; 2 atlases

and 2 maps from the Istituto Geografico De Agostini; Colton's "Dissected Map of the World," from Miss G. B. Krum; 5 school atlases and 4 school maps from Książnica-Atlas; 3 local maps of the state of Washington from Mr. Charles Metsker; 40 topographic sheets from the Mississippi River Commission; 1 map of the world from the National Geographic Society; 14 maps of New England from the National Survey Company; 11 maps from George Philip and Son, Ltd.; 1 map of Georgia from Rand McNally & Co.; 2 wall maps of the world from Professor E. Romer; 2 general atlases from Selfridge and Co., Ltd.; 1 map of England from Edward Stanford, Ltd.; "Atlas of the Tennessee Valley Region" from the Tennessee Valley Authority; "Atlas von Pommern" from the University of Greifswald; "Monumenta Cartographica Africae et Aegypti, Vol. III, Fasc. v," from Prince Youssouf Kamal; 263 township maps from the Wisconsin Land Inventory.

Gifts to the photograph collection included 14 aerial photographs taken in the United States and Mexico from Dr. R. U. Light; 20 photographs of scenes in the Orient from Mr. Victor Slocum; and 28 enlargements of photographs of Greenland and 2500 photographs of Poland from Miss Louise A. Boyd.

Approximately 7000 items were listed in the Research Catalogue and more than 7000 cards representing material published in books and periodicals as well as sheet maps were added to the map catalogue. Work was continued on the development of the Society's photograph collection and approximately 2200 photographs were catalogued. Photographs are recognized as no less important in geographical studies than books and articles and maps. The Society hopes to build up a thoroughly representative collection of geographical photographs and solicits gifts of photographs from Fellows and others. A beginning was also made during the year in cataloguing photographs of especial geographical interest reproduced in books and periodicals, thereby making available illustrative material otherwise often difficult to locate.

In addition to many requests for specific items of information by telephone, letter, and personal call, more than 450 persons used the collections during the year for research work, among them being a number of scholars from European and American universities who worked in the library and map room for extended periods and to whom special facilities were given. Among the latter was a representative from the Bodleian Library, Oxford University, who spent some weeks studying the Society's system of storing and cataloguing maps. A requested paper on the Map Department was read at the annual meeting of the American Library Association at Richmond, Virginia.

The library continued its coöperation with the Association de Géographes Français in the preparation of titles and abstracts for the Bibliographie Géographique International.

Coöperation in Other Enterprises

Three members of the staff represented the Society at the annual meeting of the Association of American Geographers at Syracuse, December 31 to January 2, and presented papers on various phases of the Society's research program. A report on the meeting appears in the April number of the *Geographical Review*.

The Society was also represented at the annual meeting of the National Research Council. At the Fifth Annual Meeting of the Population Association of America held at Princeton University, October 30 and 31, Dr. J. K. Wright, Librarian of the Society, conducted a session on population maps and mapping to which other members of the staff contributed papers. The Secretary of the Society contributed the section on cartography to the first issue of the Handbook of Latin American Studies, a guide published in 1936 by a coöperative group of scholars interested in research in Latin America.

Award of Honors

At the monthly meeting of the Society on April 21, 1936, the David Livingstone Centenary Medal was awarded to Mr. Lincoln Ellsworth in recognition of his contribution to the geography of the Antarctic by his Trans-Antarctic Flight of November 23 to December 5, 1935. Mr. Ellsworth was also elected a member of the Council of the Society at the meeting of the Council on April 8.

Lecture Program

During the year the speakers and subjects on the lecture program were as follows: Mr. C. Suydam Cutting on his "Expedition to Central Tibet in 1935"; Mr. Amos Burg, "Voyaging Fuegian Seas for Cape Horn"; Dr. Barnum Brown, "A New Dinosaur Kingdom"; Mr. Lincoln Ellsworth, "The Crossing of Antarctica from the Weddell to the Ross Sea"; Mr. Walter A. Wood, Jr., "The Wood Yukon Expeditions of 1935 and 1936"; Dr. H. L. Shapiro, "Pitcairn: The Heritage of the Bounty."

Fellows

The number of Fellows at the close of the year was 3565, of whom 245 are Life Fellows. In addition there are 9 Honorary Members and 41 Corresponding Members.

Report of the Treasurer

The Council has received a report from the Treasurer giving a summary of income and expenses of the Society, and the accounts of the Society have been audited by certified public accountants, whose report is on file at the office of the Society.

Philip W. Henry, *Chairman*

REPORT OF THE SPECIAL COMMITTEE

New York, January 26, 1937

The committee appointed at the meeting of the Council held on December 10, 1936, to nominate officers for the vacancies to occur in the Council in January, 1937, beg to nominate the following named gentlemen for the offices designated and move that the same be approved and presented to the Society for election at its meeting to be held on January 26, 1937.

		Terms to expire in
President	Roland L. Redmond	January, 1938
Vice-President	W. Redmond Cross	January, 1940
Recording Secretary	Hamilton Fish Kean	January, 1940
Treasurer	Henry Parish	January, 1938
Councilors	Philip A. Carroll Charles R. Crane William Hale Harkness Archer M. Huntington Wesley C. Mitchell	January, 1940

H. Stuart Hotchkiss
William A. Rockefeller } *Committee*
Carl C. Shippee

GEOGRAPHICAL RECORD

NORTH AMERICA

Migration of Ethnic Groups within Cleveland. In "Immigrant Colonies in Cleveland" Wellington G. Fordyce (*Ohio State Archaeol. and Hist. Quart.*, Vol. 45, 1936, pp. 320–340) calls attention to the changing pattern of settlement of the various ethnic groups residing in Cleveland. The numerical importance of the foreign elements in the population of Cleveland gives special significance to such an investigation. The United States Census of 1930 showed that 25.5 per cent of the total population of the city was foreign white and that 39.4 per cent was native white of foreign or mixed parentage. The foreign white stock consists of many diverse elements, no single group of which has ever completely dominated the city.

A study of this nature is not without its difficulties. The shift of national boundaries in Europe after the World War rendered unreliable the information relating to the nationality of many immigrants. The estimated number of Jews tends to be unreliable, partly because of their inclusion with other groups and partly because of their own responses to questionnaires. The categories used are not always refined enough. For example, the term "Russian" is used to represent at least five different groups in the population of Cleveland: refugees of the Revolution of 1917, Great Russians, Galician Russians, Ukrainians, and Carpatho-Russians.

At the beginning of the twentieth century the immigrants in Cleveland occupied "squatter" dwellings in undesirable neighborhoods known by such names as "Shanty Town," "Whiskey Island," "Goosetown," "Cabbage Patch," and "Dopetown." Two maps of foreign colonies in 1915 and 1930, reproduced in the article, show a steady displacement of the foreign groups from their original locations through the spread of the business section and the growth of industry. The displacement led to rapid disintegration of many of the numerically small colonies, including those of the Hollanders, Norse, Swedes, and Welsh, two of the three Rumanian colonies, and four of the six Hungarian colonies. Other groups moved to new locations whose selection by the migrants was frequently due to the attraction of some church or social center, as in the case of the Russians, Lithuanians, and Jews. Migration of colonies from one location to another was planned only in the case of the Chinese, whose two settlements have been dominated respectively by the On Leong Tong and the Hip Sing Tong. When forced to move, each tong picked carefully the site for the new settlement of its group.

Certain areas in the city have shown a continued process of change. Thus the area bounded by Woodland, Broadway, East Thirtieth Street, and East Seventy-Ninth Street was occupied successively by native New Englanders, Germans, Bohemians, Russian Jews, Italians, and finally Negroes. Even where the same ethnic group has remained in an area, there has frequently been a succession of subgroups. Thus "Little Italy" on Mayfield Road was occupied formerly by northern Italians and is now settled by Sicilians.

In the new locations of ethnic groups, however, the process of disintegration has continued owing to cessation of immigration, improved economic status of the immigrants, and desire of the younger generation for better homes. Disintegration of immigrant colonies has been somewhat retarded by the unemployment resulting from the depression and also by the fact that certain of the colonies, such as the Hungarian and the Rumanian, serve as centers of cultural influence for the members of their ethnic groups residing throughout the midwestern states.

Such an investigation should not be confined to the political boundaries of Cleveland but should include movements of ethnic groups or subgroups out into the suburbs and their settlement in the outer areas of the metropolitan district of Cleveland.

ERDMANN DOANE BEYNON

Erosion in the Piedmont. Since the Civil War the southern Piedmont has been one of the major problem areas of the country both socially and economically; but soil erosion, probably the greatest single problem, has until recently received attention only from scattered, individual farmers. Nearly a third of the area has lost 75 per cent or more of its rich topsoil as a result of erosion, and much of this land has been abandoned because crops could no longer be raised profitably. Industrial development of the Piedmont requires water power, which necessitated the building of expensive dams and reservoirs. But reservoirs have silted up rapidly and water power has dwindled in consequence. Both these results are due to erosion and indicate how far-reaching are its effects. The situation is described by E. M. Rowalt in "Soil Defense in the Piedmont" (*U. S. Dept. of Agric. Farmers' Bull. 1767*, Washington, 1937); and there follows a simple and lucid account of modern measures of soil defense and the work that is being done by the Soil Conservation Service to lessen the evil.

The present crisis in the Piedmont is the result of a century and a half's misuse of the land. Throughout the history of the United States erosion followed closely upon settlement, and almost immediately thereafter some of the more progressive farmers began experimenting with erosion control. Some of these experiences and experiments have been collected and described by Arthur R. Hall in a well written and thoroughly documented paper, "Early Erosion Control Practices in Virginia" (*U. S. Dept. of Agric. Misc. Publ. No. 256*, Washington, 1937).

As early as 1685 removal of soil by freshets along the James River was described. A century later Mr. Walter King is reported to have lost in one flood "in soil only at least nine thousand pounds." The James River was described as a "torrent of blood"; and the effects of silting upon navigation were deplored, the streams "being everywhere obstructed by sands, bogs, bushes, and rubbish, so as to form innumerable putrid puddles, pools, and bogs upon the occurrence of every drought . . ." George Washington, one of the founders of experimental agriculture, set out to discover "whether the land was not preserved more by harrowing than lying in furrows." Thomas Jefferson, another outstanding agriculturist, was constantly combating the problem of soil erosion; and to his son-in-law, Thomas Mann Randolph, must be given the credit for inventing the first contour plow to receive recognition in this country. As early as 1790 the Philadelphia Society for Promoting Agriculture awarded gold and silver medals for successful methods of restoring gullied fields to cultivation, and in 1811 the Richmond Agricultural Society sent out a questionnaire for the purpose of securing similar information.

Hall has shown that most erosion-control practices now in use—deep plowing, contour plowing, rotation, cover crops, and even terracing and strip cropping—were tried by individual farmers in ante-bellum Virginia. Gully dams of various types were tried, and the respective merits of stone and brush dams were considered. In 1798 William Merriwether of Amelia County devised a pair of cart wheels with ten-inch treads, which not only succeeded in preventing road gullying but also improved the condition of roads already rutted. About the same time John Taylor advocated a crop rotation to counteract the damage done by clean-tilled crops. This consisted of a year of corn followed by winter wheat and two and a half years of rest or "enclosure." During the period of enclosure the land was allowed to grow up in white clover and goose grass, which was plowed under to form "covered drains" when the land was in corn. It was urged that steeper slopes be converted into pastures; and Jefferson attempted to substitute red clover, potatoes, and sheep for the traditional corn-hog economy of the South. Farmers wrote to agricultural journals telling of their experiences in controlling erosion. Others voiced their objections. Together these comments form a valuable body of literature on the subject, covering wide ranges of territory, time, and climatic variations. Similar interest in the erosion problem has been shown by farmers in newer sections of the country also. When

assembled this literature will supplement data obtained by experiment stations and serve in lieu of experimentation in regions where such data are not yet available.

LOIS OLSON

Maturital Soil Classification as an Aid in Analyzing Regional Settlement. With recent emphasis on soil analysis in state and regional planning programs it is becoming increasingly evident that soils rank well up with climate and landform as chief factors of the natural environment influencing economic adjustment patterns. The great complexity of most technical soil reports, however, minimizes their value in land-utilization work. More than 1500 soil series have to date been identified in the United States, and any one soil map may show from 30 to 50 for a single county. For specific purposes technical classifications have an undisputed value. No intimation is made that basic soil surveys should be simplified or generalized, but it is obviously desirable to discover a method of reclassifying soils from the basic reports for study of soils as a conditioning factor in settlement patterns.

Dr. Louis A. Wolfanger, restating and extending conclusions of the late Dr. C. F. Marbut, has made an important contribution along the line of what he calls "maturital" classification of soils. Pedologists now generally agree that the basic characteristics of normal mature soils are determined more largely by the climate and vegetation under which they evolve than by the nature of the parent rock. Such a theory of soil development implies a pedological cycle of youth, maturity, and old age, each with rather definite characteristics. Geographers find this a useful classification. It has been employed to the extent that maps of mature soil types have been constructed for the United States, Europe, and Africa and are rather common in recent geographical textbooks and atlases. Thus far, however, little has been done in placing county or local soil classification on a maturital basis.

During the summer of 1934 the writer was engaged in geographic field research in the Rogue River valley, the great pear district of southwestern Oregon, in the course of which an attempt was made to correlate agricultural patterns with soil types. The only available soil source material, "The Soils of Jackson County" published by the Oregon Agricultural College after basic surveys by the Department of Agriculture, distinguished 45 types of soils. To effect a reasonably scientific simplification with human-use connotations, the pedological cycle principle was applied. By combining the geological situation of the soils with the soil characteristics at various stages in the pedological cycle the list of soil types was reduced to four.

One group, the "undifferentiated mountain soils," remained as it was. All soils of this type represent rough and stony uplands—wasteland or upland timber areas. Twenty-three types, all bearing youthful characteristics of a residual and colluvial nature on the foothill slopes rather naturally grouped themselves into the "residual-colluvial foothill soils." Because of their piedmont location, air drainage is good, and almost without exception the younger and more successful pear orchards are located on this type, as well as the peaches, cherries, and other foothill fruit characteristic of the agricultural specialization of the valley.

The third soil type obtained by the reclassification has been called the "arid and semidesert soils of the valley floor." These soils, eleven types of them originally, represent an older bottom of the valley, existing before the advent of recent uplift and the formation of newer flood plains at a lower level along the Rogue River and its tributaries. They possess all the characteristics of soils approaching old age or, at least, postmaturity. They are generally clayey with extensive areas of gravel. Ferruginous or calcareous hardpan commonly underlies all these types, hence drainage is restricted. Most of the desert soils are unused except for spring pasture. Poor drainage discourages irrigation, and such orchards as were started on them have for the most part "gone back." The fourth type, comprising the remaining ten soils,

are all recent flood-plain soils. They are subject to occasional overflow and to a definite frost hazard, hence they are given over largely to alfalfa, grains, small fruits, and vegetables.

WILLIS B. MERRIAM

Administrative and Planning Regions in the United States. Evidence that internal political divisions of the United States are ill-adapted to present needs continues to be presented. S. C. Menefee discusses county consolidation in "A Plan for Regional Administrative Districts in the State of Washington" (*Univ. of Washington Publs. in the Soc. Sciences*, Vol. 8, 1935, pp. 29–80). A brief national survey discloses the slow pace of county consolidation, despite material benefits where tried. The leading argument for county reorganization in Washington is that economy would result from more populous units. The counties with from 35,000 to 80,000 population prove to be the least expensive to the taxpayer, while counties with more than 80,000 inhabitants are less expensive, per capita, than counties with less than 35,000. Minnesota studies likewise indicate 35,000 as a desirable minimum (Richard Hartshorne: Local Government Areas, *Geogr. Rev.*, Vol. 26, 1936, pp. 146–147). Tax delinquency is found to be associated with certain parts of the state, notably the Olympic Peninsula, the Chelan-Okanogan country, and the southeast, rather than with counties of any particular size. It may be appropriate to note that H. Kehrli, in "A Comparative Study of Selected Physical, Financial, and Relief Characteristics of Oregon Counties" (*Bur. of Municipal Research and Service*, Eugene, Oregon, 1934), states that ". . . the degree of tax delinquency is the best single index of the financial condition of any county."

As a basis for scientific county consolidation, Menefee discusses geography (which he limits to physical geography), industry and resources, population distribution, communication, market areas, and districts used by governmental agencies. The significance of the Cascade Mountain barrier and of twelve cities is emphasized. The recommended plan comprises twelve districts, each with an urban center, population in excess of 50,000 (except in one case), and a high degree of industrial and transportational coherence. Existing county lines are employed for the sake of continuity in records, though some anomalies between these boundaries and circulation are pointed out. The plan seems to have but one weakness, and that apparently unavoidable: the counties with high tax delinquencies are combined in several cases, making up half of one district, three-fourths of another, and all of a third. In other words, high tax delinquency is a sign of regional unity!

"Regional Factors in National Planning and Development" (National Resources Committee, Washington, 1935), is an analogous study on the national level. The purpose of the report is to evaluate methods and regions for attacking suprastate, yet subnational, problems of regional planning. The report goes far beyond a summary statement of data and conclusions and becomes, indeed, a monograph upon regionalism in the United States. Not the least interesting feature to a geographer is the presence of 153 maps, including 108 maps of federal administrative regions and 35 other schemes of regional division. That existing state lines are unsuitable for such problems as river control needs no reiteration, yet to alter state boundaries is almost impossible and in many ways undesirable. Suprastate problems may be approached through interstate compacts, which have sometimes been successful but more often fruitless, the difficulties increasing rapidly when more than two states are involved. The history of the Colorado River compact discourages the belief that regional planning can be effected by this device. The opposite extreme is the administration of regional programs from the national capital or through regional branches of a federal department. The danger of overcentralization is considered serious. The federal regional planning authority of which the Tennessee Valley Authority is an example is regarded highly: "This unique experiment is administered

as a government corporation, 'clothed with the powers of government but possessed of the flexibility and initiative of a private enterprise . . .'"

When attention is turned from methods to regions, one finds new difficulties. Twelve social scientists are quoted, who agree that regions exist but leave vague their delimitation. That a drainage basin is unsuitable for other than engineering purposes is the consensus. The 108 systems of federal administrative regions, though doubtless adapted to their particular functions, show no close resemblance. Regions based on access to metropolitan centers are rejected because of the rural nature of many of the planning problems. "Group-of-states" regions fail to eliminate many of the anomalies of existing state lines. The authors present a tentative map of twelve regions for composite planning problems. To the objections that the Gulf Coast Region is transportationally incoherent, that it is difficult to reach northwestern Minnesota from Denver and southern Texas from Salt Lake City, and that inhabitants of northwestern California would loudly protest against inclusion in the Pacific Northwest, the authors might reply that the contemplated planning problems are largely rural and are limited in nature to what a capitalist society considers "public business." The question "How much planning is possible in a capitalist society?" is not posed in this report.

A conclusion that one may draw from "Regional Factors in National Planning" is that regional governments, intermediate between the states and the nation, are unwise, because of the difficulty of compressing many functions of government into one set of boundaries. Regional authorities responsible to the federal government, with "elastic boundaries," seem most promising.

STEPHEN B. JONES

SOUTH AMERICA

Iguazú National Park, Argentina. In 1928 the government of Argentina acquired a 75,000-hectare tract of land bordering the impressive cataracts of the Iguazú River and created the Parque Nacional del Iguazú. In 1920 the region was practically uninterrupted virgin forest. First expioitation of forest resources began late in 1920 (F. E. Devoto and Maximo Rothkugel: Informe sobre los bosques del Parque Nacional del Iguazú, *Bol. Minist. de Agric.*, Argentina, Vol. 37, 1935, pp. 129–225). Lumbering procedure was haphazard. Trees of economic value were "discovered" by workers traveling at random through the forest and reported to overseers. Unsatisfactory results temporarily discouraged operations. Shortly afterwards, however, a system of "tendidas" was organized. The "tendida," a unit of 100 hectares, was employed to divide the forest arbitrarily into referable units during lumbering operations. In view of the fact that the four economically valuable species of trees occur as isolated individuals in dense mixed forest, some such procedure was necessitated in order to insure profits. By 1927 major logging operations had been discontinued, although this by no means implies that all valuable trees had been removed.

Great areas of the exploited forest of the Alto Paraná and the Iguazú have been considered suitable for agriculture and colonization. The difficulties besetting the colonist are, however, numerous. Clearings must be made, crops such as yerba maté must be planted. As only a small part of the available timber is at present of economic value, it is said that the sale of lumber will rarely pay the colonist for the cost of clearing the land.

Recovery of this land on the Argentine side of the Iguazú by the government insures preservation of the cataracts in their primeval setting. They are easily accessible (Gino di Passera: Una excursion a las cataratas del Iguazú, *Rev. Geogr. Americana*, Vol. 4, No. 22, 1935, pp. 1–14; M. A. Mark: El Parque Nacional del Iguazú, *ibid.*, Vol. 6, No. 34, 1936, pp. 23–25) by means of boats and connecting automobile road and in all probability will be visited increasingly by vacationists.

EUROPE

The Morphology of the Cities of the Alföld. The official statistics of the census of Hungary seem to support the assumption that the so-called "peasant cities" of the Alföld are rural rather than urban both in the occupational composition of their population and in their structure. However, each of these cities includes under its administrative control a restricted urban area of compact settlement as well as an extensive but sparsely settled *tanya* area. Dr. Tibor Mendöl, partly by the use of unpublished census material, was able to delimit those areas of the Alföld in which there were compact settlements of 10,000 inhabitants or more: excluding then the rural *tanya* areas, he attempted to analyze the structure of the urban areas of 27 cities (Alföldi városaink morfológiája, *Tisia*, Vol. 1, Debrecen, 1936, pp. 3–44).

Each of the cities studied seemed to be composed of a series of more or less concentric zones through which one passed from the center of compact settlement to the periphery. These zones were distinguishable by both structural and functional indexes. From the center out each zone had an increasing proportion of agriculturists in its population and a decreasing proportion of nonagriculturists. Official statistics failed to show accurately the location of residence and of work by occupational class. The author assumes that the occupational groupings of the population of the different zones correspond to changes in the structural aspects. The occupational composition of the residents tends to be reflected in the type of buildings. By accurate observation of the increase in vertical expansion and in horizontal compactness a series of zones may be delimited from the periphery to the center of any one of the areas of compact settlement on the Alföld.

The principal indexes of the urban zones were two: (1) horizontal compactness, ranging from the solid blocks of stores or apartment houses in the center of the city to the peasant homes on the periphery, where the houses faced and were separated from each other by wide courtyards; (2) vertical expansion, ranging from the many-storied buildings in the center to the one-storied houses of the outer zones.

Supplementary indexes were furnished by: (3) the type of store or business. The types range from the undifferentiated general store serving the daily needs of peasant customers to the highly specialized stores of the center. None of the cities of the Alföld, however, show that still higher type, the metropolitan pattern of segregation of wholesale enterprises, financial institutions, etc. (4) Land values. The increasingly intensive use of land toward the center of the city—horizontal compactness and vertical expansion—is readily correlated with a rise in land values. (5) Occupational composition of the population. The trend is, just as in American cities, "from within out." The agriculturists are being constantly pushed farther out into the ever expanding periphery.

The urban zones based on the above indexes are shown most clearly in Debrecen, in which seven zones are delimited. (1) The *nagyvárosias formacsoport*, the solid blocks of many-storied buildings characteristic of large cities. In the Alföld cities this zone includes both residence and business. The business activities are highly specialized. This zone is found only in the following cities of the Alföld: Debrecen, Szeged, Szolnok, Békéscsaba, Nyíregyháza, Kecskemét, and Hódmezővásárhely; though in none of these cities except Debrecen, Szeged, and Kecskemét is the zone of any significant size. (2) The small-town business quarter—solid blocks of stores of the market-place type. In those with two stories the upper story is used for residence. This type of structure is found on every street branching out from the center. In all the Alföld cities named above, the center and this zone together form the nucleus of the city; in the other Alföld cities this zone alone is the nucleus. (3) The small-town residence area. (4) The *hézagos kispolgári házsor*—the irregular lines of houses of the *bourgeoisie*. Handicraftsmen and officeholders tend to live in the third zone; the fourth usually has residents of still lower economic status, together with

"islands" of the decreasing agricultural population. (5) The *hóstát*, settled originally by day laborers on the outskirts of the city, is still occupied by the very poorest of the people. (6) The zone of industry and commerce. In the region of cemeteries and unbuilt areas fringing the old limits of the city there has developed this zone, in which factories and storehouses may obtain the extensive areas of land that they require. (7) The "gardens," a zone of loose agglomeration on the outskirts. This peripheral zone was originally occupied by agriculturists. Since the middle of the nineteenth century the excess population of the inner zones has "leaped over" the fourth, fifth, and sixth zones and has settled in the suburbs. This zone has expanded in sectors along the main highways rather than concentrically.

The author seems to have developed his technique for the delimitation of urban zones without acquaintance with the parallel researches carried on by American students during the past ten years. E. W. Burgess (Residential Segregation in American Cities, *Annals Amer. Acad. of Polit. and Soc. Sci.*, Vol. 140, 1928, pp. 105–115) points out the well known pattern of five urban zones found in most American cities. Mendöl's first and second zones of Alföld cities correspond to Burgess' central business section. Mendöl's "gardens" correspond to Burgess' suburban zone. Mendöl's sixth zone—that of heavy industry and commercial warehouses—is being increasingly recognized by American students of urban structure. The principal difference, then, between the two patterns is found in Mendöl's third, fourth, and fifth zones. Instead of a socially disorganized area in transition, such as is found in American cities, the Alföld cities have a better residence area surrounding the central business section.

ERDMANN DOANE BEYNON

The Center of Area and the Center of Population of Yugoslavia. Additional evidence of the international interest in the study of concentration and trends of population by computing "centers of population" is furnished by a recent monograph in which Professor Aleksandar Bilimović of the University of Ljubljana reports the results of computing the center of area for 1933 and the center of population for 1921 and for 1931 of Yugoslavia (*Éditions Spéciales Soc. de Géogr. de Beograd No. 19*, 1936). The author uses essentially the methods of the United States Bureau of the Census and of the Russian chemist Mendeleev, cities of 10,000 inhabitants or more being treated separately from the districts or departments in which they are located. The center of area in 1933 was 44° 7′ N., 18° 56′ E. (Incidentally it is worth noting that the French summary of the monograph gives the latitude as 47° 7′ N., which is inconsistent with both the map and the data of the text.) The center of population in 1921 was in 44° 27′ N., 18° 43′ E.; in 1931 it was in 44° 27′ N., 18° 47′ E.—in exactly the same latitude but five kilometers east of its position a decade before. It is significant that this direction of movement is in line with the general tendency of the center of population of various countries in the eastern hemisphere to move eastward (see the article by Sviatlovsky and Eells in the present number of the *Geographical Review*, pp. 240–254). The fact that the center of area is 37 kilometers south of the center of population summarizes statistically the tendency of the population to concentrate in the northern part of the country.

WALTER CROSBY EELLS

POLAR REGIONS

Valley-Forming Processes in the Arctic. The majority of nonglacial morphologic papers that have thus far come out of Arctic studies have dealt with broad features of preglacial relief. In Hans Poser's "Talstudien aus Westspitzbergen und Ostgrönland" (*Zeitschr. für Gletscherkunde*, Vol. 24, 1936, pp. 43–98) we have a rather detailed treatment of the morphology of certain small valleys in Greenland and

Spitsbergen that are being shaped by periglacial processes widely present in these regions. The valleys selected for study drain into Kings Bay in northwestern Spitsbergen and into Young Inlet (74° 30′ N.) in East Greenland. None are more than a few kilometers in length, and most of them range from 10 to 20 meters in depth. They are excavated in detrital accumulations and in bedrock capped with detritus, but in no instance does bedrock lithology or structure control valley form.

Poser believes that channeling by streams is relatively less important than in lower latitudes and emphasizes the processes of solifluction, landsliding, slope wash, and dragging by snow sliding. Although the morphologic role played by solifluction has been pointed out by Andersson, Ekblaw, and others, Poser shows that it operates selectively on valley slide slopes in detrital material, reducing them to a low-angle, concave-up profile where summer snow banks are not present but, where snow banks persist through much of the summer, operating only on the snow-free surface, thereby giving a relatively steep slope. Where thawing results in a shallow zone of mobile material resting on still-frozen ground below, conditions are ideal for slope wash. The thaw water trickles over the impermeable frozen floor and, when forced to emerge at the surface by its own increase in volume, flushes away the fine material and leaves the stones as a lag gravel, which forms a conspicuous armor on many slopes. This process appears to be closely analogous to the one described by Shaw from various parts of the United States (*Geogr. Rev.*, Vol. 19, 1929, p. 638).

Some valleys described carry fills of unknown thickness, which give them nearly flat floors over which flow threads of meltwater emanating from glaciers or, more commonly, large areas of snow. Poser attributes this filling to temporary decrease in discharge, and hence loss of capacity, in consequence of variable snow drifting and seasonal melting caused by weather conditions peculiar to individual valleys rather than to the region as a whole.

The paper concludes by calling attention to certain dry valleys in Germany that resemble the Spitsbergen and Greenland valleys studied and, it is suggested, owe their origin and form to special Pleistocene periglacial conditions no longer existing.

RICHARD FOSTER FLINT

A Bibliography of Novaya Zemlya. The quantity of publications that exist concerning remote and seldom-visited places is always surprising to the layman. In "A Bibliography of Novaya Zemlya" (Arctic Institute of the U. S. S. R., Leningrad, 1935) no fewer than 2645 references are given, most of them being Russian works. The principal headings and the number of items listed under each are as follows: bibliographies, 29; expeditions, 674 (Russian expeditions, 377; others, 297); general description, 145; astronomy and geodesy, 49; cartography, 144; geology and paleontology, 163; meteorology, 381; botany, 119; zoölogy, 230; hunting and fishing, 171; colonization, 190. Brief comments (in Russian) are appended to many of the references. The volume is the first of a series of bibliographies on the Arctic regions projected by the Arctic Institute.

PHYSICAL GEOGRAPHY

Zones of Physical Comfort. In line with the investigations of Griffith Taylor and the traditional, possibly self-conscious, interest Australians display with regard to the environmental limitations of their continent, Henry Barkley (Zones of Relative Physical Comfort in Australia, *Commonwealth of Australia Bur. of Meteorol. Bull. No. 20*, 1934) has mapped zones of relative physical comfort in Australia according to a system that is readily applicable to other parts of the earth and that deserves the attention of climatologists everywhere.

Dual references, such as temperature and humidity, Barkley regards as unsuited to cartographic representation or extended comparisons. Relative humidity has

been accorded "unmerited pre-eminence" as a measure of personal comfort. "It is an excellent index of drying conditions for inanimate objects, but its usefulness ceases there."

Personal experimentation and the experiences of a meteorological observer on the south coast of Queensland led to the conclusion that atmospheric vapor pressure is, under most conditions, the best criterion of personal comfort. The locations of successful sanatoria for those undergoing treatment for the lungs have one thing in common—low absolute humidity.

When the vapor pressure rises above half an inch, transpirational outflow is checked sufficiently to raise the body temperature and cause discomfort and perspiration in the average white man. When it falls below one-fifth of an inch, the transpiration is too rapid, because there is too little resistance to the outward pressure from the skin and lungs. If, under this condition, the air is hot and dry, the mucous membranes of the nose and throat become parched; but if the air temperature is low, the sensation of cold is felt, owing to the rapid loss of heat.

For mapping zones of discomfort in Australia, the mean vapor pressure at 9.00 a. m. for each month was used. This value is a close approximation to the mean of the 24 hours. Each tenth of an inch of vapor pressure above or below the limits of comfort (0.2 to 0.5 inch) in each month was reckoned as a unit of discomfort. The sums of these units for the twelve months were then reduced to a logarithmic scale, and this number was halved to get convenient degree numbers on the scale of discomfort. This gives duration an equal weight with intensity of stimulus. The introduction of the logarithm effects a convenient reduction of the scale and provides for the law governing physiological response, by which Sensation = log Stimulus.

The zero isopleth on the map of Australia, which marks the northern boundary of the territory experiencing not more than two weeks of uncomfortable weather during the average year, extends from slightly north of Perth to slightly south of Sydney. It swings slightly north of the Tropic of Capricorn just east of Alice Springs and to the Tropic in the vicinity of the Teano Range. The most uncomfortable part of Australia, beyond the isopleth value of "8," lies between the latitudes of Thursday Island and Darwin. Brisbane is only slightly less comfortable than Sydney or Canberra. Discomfort arising from a too cool condition occurs in the mountains of southeastern Australia and on the Tasmanian tablelands. Only toward the central part of the continent does the warm deficiency of moisture become a regular climatic factor. Australian cities do not reach the adverse extremes reached by New York and Chicago every year. Rio de Janeiro, the second largest city in the southern hemisphere, is never more than a fortnight within the zone of complete comfort.

Barkley seems to have clearly in mind the concept of climates in terms of areas: "During occasional expansions of this [warm deficiency of moisture] area in dry years the adverse effects are felt in the winter months in the inhabited hinterland. Some non-occupational disease, for instance, affects men, women, and children in Broken Hill at intervals of approximately six years, when the vapour pressure (absolute humidity) is lower than usual, and the results are reflected in the death rates of that city."

RICHARD JOEL RUSSELL

Steps toward a Physical Theory of Stream Action. Between the classic deductions formulated by G. K. Gilbert in his "Report on the Geology of the Henry Mountains" (U. S. Geographical and Geological Survey of the Rocky Mountain Region, Washington, 1877) and modern discussions of the work of streams (for example, M. P. O'Brien: Notes on the Transportation of Silt by Streams, *Trans. Amer. Geophys. Union, Seventeenth Ann. Meeting, 1936*, Washington, 1936, Part 2, pp. 431–436) lie not only sixty years but, in addition, a rather complete orientation of think-

ing. Here, as in several other branches of earth science, much in the way of *ad hoc* terminology is being replaced by concepts common to a wide range of physical theory. A good deal of the literature that bears witness to this reorientation is listed in the bibliography accompanying the Report of the Committee on Dynamics of Streams of the American Geophysical Union published in the *Transactions* of the Union in 1935 (*Sixteenth Ann. Meeting, 1935*, Part 2, pp. 443–451). That much of the work being done is in the hands of technologists makes it no less significant to the physical geographer. The engineers are taking with very good grace to the new ways of thinking that hydrodynamics is forcing on them, as may be seen if one does no more than casually leaf through recent volumes of the technical journals; as evidence, and in addition as a good introduction to the theory of turbulence, may be cited Hunter Rouse's admirable summary "Modern Conceptions of the Mechanics of Fluid Turbulence" (*Proc. Amer. Soc. of Civil Engineers*, Vol. 62, 1936, pp. 21–63 and discussion in later numbers of the same journal).

But the engineers have not contributed any summary of the principles immediately applicable to streams that surpasses the one contained in a recent Uppsala dissertation in geography, by Filip Hjulström (Studies of the Morphological Activity of Rivers as Illustrated by the River Fyris, *Bull. Geol. Instn. Univ. of Upsala*, Vol. 25, 1935, pp. 221–527). Hjulström's dissertation consists of two parts: the first is a general discussion of the mechanics of streams, and the second an account of "the amount of mechanical sediment and dissolved matter in the water [of the Fyris] passing a profile just north of the town" (Uppsala) during five years by days, between July 1, 1929, and June 30, 1934. The principal emphasis of the second part necessarily rests on a correlation of fluctuations in transport with changes in weather —rainfall, melting of snow, alternation of open and ice-covered water—and in water stage. The chief limitation on general applicability of the results arrived at inheres in the fact that the Fyris carries no bed load but transports matter only in suspension and solution.

The reader who seeks generally applicable principles is likely, therefore, to find more of interest and profit in the chapters entitled "The Dynamics of Streams," "Solid Matter in Bed-Load and Suspension," and "Erosion, Transportation and Deposition," which together occupy slightly more than the first half of Hjulström's work. Such a reader will find here a digest of most of the hydrodynamic principles available at present for the interpretation of the work of streams. He will find, however, much more than a summary of other people's work: ingenious observations and measurements made by the author himself are interspersed that deal with such problems as the effect of suspended matter on viscosity of water; critical velocity at which turbulence appears in thin sheets of water flowing over an artificially roughened surface; and, most important of all, distribution of intensity of turbulence, expressed by Wilhelm Schmidt's Austausch coefficient, over the cross section of a laboratory channel. There are also penetrating discussions of the resistance to traction of rock fragments of different size, with conclusions regarding superposition of layers of different degrees of coarseness in stream deposits; and of the relation of Gilbert's phases of traction ("dune," "smooth," "antidune") to transportation and scour.

Hjulström has used mean velocity as a measure of the capacity of a stream to transport. Such a simplification is permissible only when at least the cross section of the stream and the roughness of its bed remain constant. Laboratory investigations of movement of bed load (for example, Hans Kramer: Sand Mixtures and Sand Movement in Fluvial Models, *Proc. Amer. Soc. of Civil Engineers*, Vol. 60, 1934, pp. 443–483; M. P. O'Brien and B. D. Rindlaub: The Transportation of Bed-Load by Streams, *Trans. Amer. Geophys. Union, Fifteenth Ann. Meeting, 1934*, Washington, 1934, Part 2, pp. 593–603; and "Studies of River Bed Materials and Their Movement, with Special Reference to Lower Mississippi River," *U. S. Waterways Exper. Sta. Paper 17*, Mississippi River Commission, Vicksburg, Miss., 1935) lead

to a more rational formulation in terms of depth and gradient. Eventually, however, the relation of mean velocity to the distribution of velocity in cross sections of different shapes and under various conditions of shear on the bed and of suspended load will be worked out. Then mean velocity will become something more than the rough approximation it is at present, and better correlations than can now be established will become possible.

JOHN LEIGHLY

HUMAN GEOGRAPHY

Road Transportation. "In the sixteen years since the war, road transport has developed out of all recognition and has had repercussions on the whole economic and social structure."

"The motor car has brought about a new epoch in the economic and social life of all nations, a fact which no means can undo and which can no longer be got rid of."

"Able to travel anywhere on a road system that penetrates wherever people live, usable by all on equal terms, inviting each to the pursuit of whatever form of enterprise his personality and circumstances may suggest, its [the motor vehicle's] social and civilizing influence is enormous and inescapable."

These three sentences, similar in content and conclusion, are taken from three different publications each of which deals with widely different aspects of the transportation problems of today. The first quotation is from a paper presented to the Royal Statistical Society by K. G. Fenelon entitled "Road Transport in Great Britain since the War" (*Journ. Royal Statist. Soc.*, Vol. 98, Part 2, 1935, pp. 293–346). This paper presents, by means of statistical tables and clearly written comments, a localized but well-nigh complete picture of the amazing growth of road transportation in Great Britain and its attendant problems of road classification, finance and administration, taxation, employment, and accidents. No attempt is made to draw conclusions from the facts presented, but the paper and especially the spirited discussion following it serve to show that even in the highly organized "tight little island" there are many and various problems urgently calling for solution and that there is by no means unanimity of opinion as to the significance of the facts presented or the methods whereby the problems can be solved. Take, for instance, the question of accidents. In 1934 there were in round numbers 7000 persons killed and 200,000 injured on the roads of Great Britain. To some of the authorities taking part in the discussion this, although admittedly serious, was not alarming, since the ratio between accidents and increase of traffic had not materially increased. To others the figures were nothing short of dreadful, and the Minister of Transport was quoted as saying that he would have nothing to do with ratios but was only concerned with reducing accidents. In contrast with this point of view was the idea that no constructive steps could be taken in this matter until it was studied geographically, to find out where the accidents occurred and what were the densities of traffic or the peculiar local conditions in the danger spots.

The second quotation is taken from "Railway and Highway Transportation Abroad" by W. Rodney Long (*U. S. Bur. of Foreign and Domestic Commerce Trade Promotion Ser. No. 155*, 1935), a study of relationships, recent competitive measures, and coördination policies in most of the principal countries of the world. Material for this study was obtained from replies to questionnaires directed to all foreign offices of the Bureau of Foreign and Domestic Commerce and to those State Department officers located in countries where the Bureau has no offices and also from such unofficial sources as transportation, technical, and trade publications. A valuable list of all sources is given in one of the appendixes. The purpose of the survey is simply to relate facts; but the result, besides being a mine of information on the transportation problems of the world outside the United States, makes an interesting and readable account. A large part of the publication is devoted to reporting the

attempts at coördinating rail and road transportation, but a variety of other matters are also dealt with.

The third quotation is taken from a publication of an entirely different nature, entitled "Railways and Roads in Pioneer Development Overseas" by J. Edwin Holmstrom (P. S. King & Son, London, 1934). The purpose of the study has been to discover empirically from the statistical experience gained in pioneer development all over the world at just what point in the economic development of an area a railroad becomes superior to a road in the production of wealth for that area. The dominant principle of the book is that transportation is fundamentally a producer of wealth and not merely a convenience, and with this constantly in mind the effort is made to determine the cheapest way to produce this wealth under the various conditions to be met with in pioneer development. First the problem is explained in three chapters dealing with what the author calls the "anatomy," the "morphology," and the "physiology" of transport. These chapters are of absorbing interest to laymen such as the reviewer, being full of fascinating allusions. For example, the camel is the only pack animal that improves earth road surfaces instead of damaging them. The greater part of the book, however, to use a fitting metaphor, proceeds by tunneling through a mountain of statistics to emerge into a bright and lucid region of conclusions. The problem and the objective are never lost sight of, however; and the author warns his readers that the statistical method must not be taken too seriously and that the introduction of mathematics into the inquiry is mainly for the purpose of obtaining greater clarity of thought. For the engineer and the economist, empirical laws may be formulated; but in the last analysis it is the statesman with the political and geographical background in view who should make the final judgment as to what form of transportation is best suited to the area to be developed. The book is remarkably well written and contains a valuable bibliography.

The three publications discussed may be taken as fair examples of the interesting publications that are being produced dealing with road transportation since it assumed its present importance. The voluminous literature on the subject, particularly concerning the United States, has been frequently brought to the attention of readers of the *Geographical Review* (for examples see Vol. 15, 1925, pp. 496–498; Vol. 18, 1928, pp. 307–309; Vol. 20, 1930, pp. 327–328; and Vol. 22, 1932, pp. 484–485).

In conclusion, the historical and cultural aspects of roads make a fascinating study. Indeed, with some it becomes an absorbing hobby. A noteworthy book on the historical development of roads in New England is Frederic J. Wood's "The Turnpikes of New England" (Marshall Jones Company, Boston, 1919). In Great Britain two recent books dealing with this aspect of roads are "From Track to By-Pass" by T. W. Wilkinson (Methuen & Co., London, 1934) and "From Track to Highway" by R. Gibbard Jackson (Ivor Nicholson & Watson, London, 1935).

GEOGRAPHICAL AIDS

Recent Bibliographies on Latin America. The bibliography, critically selected and annotated, has come to be one of the most important and necessary tools of research and the bibliographer one of the research worker's best friends. Of the many requests for information and assistance that come to the American Geographical Society, a large proportion is for selected lists of references. The problem of what source material dealing with his subject is available, what work has been done, and what studies are currently under way has come to be almost insurmountable for the individual setting about a particular piece of research.

When it is considered that, in compiling the sections devoted to "Maps in Scientific Periodicals" in the four-volume "Catalogue of Maps of Hispanic America" published by the Society, it was necessary to examine the files of more than 400

periodical publications, printed in eight European languages and running into thousands of volumes, some idea may be had of the task confronting the research worker who is obliged to depend on his own efforts. Furthermore, in spite of the important part played by the periodical in the publication of results of research (see below, "Recent Geographical Indexes"), the average library catalogue gives no clue to the contents of its files of periodicals. At the Society the problem of easy access to recent publications is solved by a Research Catalogue, regionally and topically arranged, that affords a critically selected index to periodical articles, books, pamphlets, and maps accessioned since the catalogue was started in 1923. The volume "Aids to Geographical Research," published by the Society in the same year, is designed to provide a guide to the most important bibliographical work in geography and allied sciences and to the scope and character of periodical and serial publications.

Students and scholars who have chosen Hispanic America as their field find particularly difficult the task of locating material that has been published in the Hispanic American countries themselves. The need for bibliographies of this material is, however, finding expression. At the Sixth International Conference of American States in 1928 a resolution was adopted setting forth the need for Inter-American coöperation in bibliographical work and authorizing the Pan American Union to appoint a permanent committee to work out plans. At the Seventh Conference in 1934 the recommendations of this committee were presented and approved. If funds are made available and the necessary coöperation can be developed, the result would be a sort of "Union Catalogue" of the more important libraries in the American countries accompanied by arrangements for various sorts of interlibrary exchanges.

Meanwhile, some essays at Hispanic American bibliography are being made in the United States. The Pan American Union has issued in mimeograph form a number of bibliographies that, although for the most part not critically selected, are of value where there has previously been little bibliographical aid. Among these are a "Selected List of Recent Books (in English) on Latin America," "Theses on Pan American Topics Prepared by Candidates for Degrees in Universities and Colleges in the United States," and a "Selected List of Books and Magazine Articles on Inter American Relations," compiled under the direction of Charles E. Babcock, librarian of the Union. Three bibliographies prepared by A. Curtis Wilgus, sponsored by the Central Committee of the Inter-American Bibliographical Association and published in mimeograph form by the Pan American Union, should also be mentioned. "The Histories of Hispanic America: A Bibliographical Essay," consists of brief notes on outstanding historical works and other works with historical content from the sixteenth century to the present time. "Maps Relating to Latin America in Books and Periodicals" is a list of some 5000 items compiled at the Library of Congress and the Pan American Union. The maps are listed by topics and by countries or larger divisions. No indication of scales is given, and the list is in no sense critically selected. The greater part of the items are from books, largely in English. "Source Materials and Special Collections Dealing with Latin America in Libraries of the United States," prepared for the Inter-American Conference on Bibliography at Havana in 1934, consists of brief notes on the types of material available in 79 libraries.

An excellent feature of *The Hispanic American Historical Review* is the inclusion of a bibliographical section in each issue. Lists of material on special topics are presented together with notes on bibliographical studies which, while chiefly historical, frequently include bibliographies of geographical material. "A Guide for the Study of British Caribbean History, 1763–1834," by Lowell Joseph Ragatz (*Ann. Rept. Amer. Hist. Assn., 1930*, Vol. 3) consists of lists of books, documents, manuscripts, public acts, etc., compiled from collections in 69 libraries in the United States, Canada, Great Britain, Jamaica, France, Belgium, and Switzerland. Much

material of geographical interest is included. Brief notes accompany most entries. Unfortunately, the value of the work to the research worker is greatly diminished by the fact that there is no indication of the libraries in which the items listed are to be found.

A bibliography of special value to geographers is "The Economic Literature of Latin America: A Tentative Bibliography," compiled by the staff of the Bureau for Economic Research in Latin America, Harvard University (Cambridge, Mass., 1935). The entries are classified by countries and topics, the latter being under four main headings: Economic and Social Theory, The Indian Economy, The Colonial Economy, and The Period since Independence. The notes introducing each of the topical sections are particularly valuable since they indicate and briefly describe the most important sources of material dealing with the topic. Access to the material of special interest to geographers is made easy by subdivisions under each main topic.

One of the most vexatious problems confronting the research worker is that of keeping abreast of current work and publications. An attempt to solve this problem in the Hispanic American field is the first issue of a "Handbook of Latin American Studies: A Guide to the Material Published in 1935 on Anthropology, Archaeology, Economics, Geography, History, Law, and Literature" (Cambridge, Mass., 1936). The volume was published with funds furnished by the American Council of Learned Societies. It represents the outgrowth of a conference held in 1935 by a small group of specialists from a number of American universities, the Library of Congress, and the American Geographical Society, to consider means for developing closer cooperation among research workers interested in Latin American studies in a variety of fields. The volume consists mainly of lists of publications with brief descriptive annotations, most of the sections being introduced by short articles on trends in research work, leading personalities, the outstanding work of the year, etc. In this first issue little attempt has been made at uniformity of presentation, nor are all of the subjects adequately treated. It is to be noted that the sections on archaeology and ethnology deal only with Mexico and Central America and that the sections on the geography of the Caribbean area and South America are only lists with brief annotations lacking the introductory notes that precede most of the other sections. This omission will doubtless be corrected in subsequent issues, since the need that the Handbook is intended to fill is of information on current research work, and it is hoped that it may be continued as an annual publication.

Recent Geographical Indexes. Since 1918 the Royal Geographical Society has issued printed lists of the material added to its collections. These lists, "Recent Geographical Literature, Maps and Photographs," are published as Supplements to the *Geographical Journal* and their usefulness has now been greatly increased by the publication of an "Index to Supplements to the Geographical Journal: Recent Geographical Literature. Supplements. Volume I-IV. Numbers 1–41: 1918–1932." London, 1936. As the preface states this index is not only an index to the Supplements but "forms a guide to the more important geographical literature published in many countries from the end of the war to 1932." All of the material listed in the Supplements is included with the exception of "maps, photographs and a proportion of the less important articles in periodicals." The final date of the Supplements indexed was determined to correspond with that of the "Fourth General Index to the Geographical Journal. Volumes LXI to LXX, 1923 to 1932," London, 1935.

Another valuable guide to geographical literature is contained in the "Inhaltsverzeichnis von Petermanns Mitteilungen, 1905–1934," Gotha, 1936. Of the 402 pages comprising the volume, 251 are devoted to "Literaturberichte." The topical and regional arrangement of this material aid the user by enabling him to find in one section all of the material reviewed for a given region or topic. The major divisions are continental, subdivided into countries, with further subdivisions into the major

regions within a country. There is also an author index. Useful also are the two series of maps showing areas covered by the maps published in the *Mitteilungen*. These have been divided into the periods 1905–1914 and 1915–1934.

To commemorate the conclusion of fifty years work, the Scottish Geographical Society has issued "The Scottish Geographical Magazine Index to the First Fifty Volumes, 1885–1935." Edinburgh, 1935.

Three indexes published in the United States also ought to be mentioned. The Association of American Geographers has marked the completion of twenty-five years of publication of its *Annals* (1911–1935) by issuing an "Index for Volumes I to XXV," by Arthur A. Brooks. The National Geographic Society has issued a "Cumulative Index to the National Geographic Magazine, 1899 to 1936, Inclusive." Washington, 1937. An "Index to the Geographical Review" for the years 1926 to 1935 was noted in the January number of the *Geographical Review* (p. 139).

OBITUARY

Oliver Lanard Fassig. Oliver Lanard Fassig died in Washington on December 6, 1936, in his seventy-seventh year. Dr. Fassig had for fifty years (1883–1932) been in the service of the U. S. Weather Bureau. A large part of this time was spent in Puerto Rico, where he organized the West Indies and Caribbean climate and forecasting service of the Weather Bureau and where he collected with painstaking care the vast store of data that forms the basis of his magnum opus, the climate of Puerto Rico. This work was practically completed at the time of his death, and it is understood that it will be published by the Weather Bureau under the editorship of Dr. C. F. Brooks of the Blue Hill Meteorological Observatory, of which institution Dr. Fassig was a research associate. Earlier in his career Dr. Fassig had for a number of years been in charge of the weather station at Baltimore, Md. Here also he gave instruction in meteorology at the Johns Hopkins University and wrote "A Report on the Climate and Weather of Baltimore" (1904–1905) that, according to Dr. Brooks, "served as a model for analyses of the climate of other cities." Dr. Fassig also contributed chapters on magnetic observations and climate to "The Bahama Islands" of the Geographical Society of Baltimore (1905), and he participated in the Ziegler Arctic Relief Expedition in 1905. An appreciation of Dr. Fassig's work to which "American climatology owes much of its scientific flavor" appears in the January, 1937, issue of the *Bulletin of the American Meteorological Society* together with a bibliography of his writings.

Dr. Fassig was a member of the Association of American Geographers. To the *Geographical Review* and its predecessor, the *Bulletin of the American Geographical Society*, he had contributed notes and reviews; and at the time of his death he had in preparation for the *Review* an article on Caribbean weather from the viewpoint of aviation, dealing with his upper-air researches. It is hoped subsequently to publish some account of this work.

GEOGRAPHICAL REVIEWS

Canadian Frontiers of Settlement

A. R. M. Lower. **Settlement and the Forest Frontier in Eastern Canada**; Harold A. Innis. **Settlement and the Mining Frontier.** xiv and 424 pp.; maps, ills., index. (Canadian Frontiers of Settlement, Vol. 9.) Macmillan Company of Canada Limited, Toronto, 1936. $4.50. 10 x 7 inches.

The land policies of Canada and the United States have been at many points divergent. Whether by accident or by design, most of the Canadian Provinces have at their disposal the means of effecting both a sound and socially desirable land settlement activity and a program of forest utilization that will serve the public interest, means which the United States cast aside in the scurry of rapidly expanding occupancy and which it has recently been trying to reacquire.

Part I of this volume in the Canadian Frontiers of Settlement series (see *Geogr. Rev.*, Vol. 25, 1935, pp. 92–106) is entitled "Settlement and the Forest Frontier in Eastern Canada." In it Dr. Lower describes the setting of land settlement in the eastern provinces of the Dominion and traces the development of Canadian land policy, showing in some measure its effect on land settlement and on attendant social and economic problems. Part II is entitled "Settlement and the Mining Frontier." Here Dr. Innis describes the character of frontier settlement in the Yukon Territory, in the Kootenay district of western Canada, and in the mining districts of northern Ontario; he describes the effect of changing techniques in mining and new methods of transport on the character of mining occupancy and shows in some measure the relationship of mineral exploitation to the development of other resources supporting land occupancy.

In contrast to the policy followed by the United States until rather recently, the Canadian Provinces have followed the practice of not alienating Crown (public) lands except for purposes of agricultural settlement, and then only after examination has shown them to be suitable for agriculture. Title to the bulk of Canadian forest land therefore rests with the public, which can, subject to the pressure and forces that a democratic government must meet, use its power of ownership to develop and control its use in a manner favorable to the public interest. The interesting question at once arises as to whether possession of this instrument has resulted in a type of land exploitation socially more desirable than in the United States, where the use of land has been left more fully to the free will of its occupants. Attitudes toward land and land settlement seem to have been much the same in the two countries, both sharing the belief that expansion of settlement was desirable.

Since 1877 in Quebec and shortly afterward in Ontario, lands have not been opened for legal entry by settlers until they have been surveyed and their agricultural quality determined. Tracts have been opened for settlement in such a way as to confine settlement in fairly compact communities and avoid the dispersion that might result from uncontrolled alienation of land. Furthermore, both provinces, in selling the right to cut timber from Crown lands, have applied certain regulations concerning the manner in which cutting shall be carried on. Also, in the right to grant or withhold licenses to cut timber or pulpwood, the provinces have in their power the means to effect an orderly and economic utilization of forest resources. How well has government exercised its power? One would like to study the character of land settlement in the frontier regions of eastern Canada to see if settlers and their local governments are in as large a measure beset with difficulties as they are in our own cut-over sections, where essentially no controls over the place and rate of settlement were exercised. One would like to know whether power to regulate forest utilization has resulted in a treatment more in the public interest than is found on most of our

privately owned forest lands where little regulation has been applied. One wishes that Professor Lower had considered more fully the extent to which Canadian policies in land settlement have given rise to uneconomic patterns of land settlement and excessive public costs.

While no adequate comparison between the two countries is provided by this volume, it is apparent that in Canada, as in the United States, the pressures and public attitudes that shape public policy in a democratic country have forced, or at least concurred in, practices that have not well served the public interest. Despite the policy of classifying land before settlement, settlement has been permitted, perhaps even encouraged, on land wholly unsuited to it, and the timber licensing of Crown lands has sometimes served better a given private interest than the public. The inference appears to be that in a democratic regime, the best instruments for effecting good land use and land settlement are impotent unless supported by a strong body of public opinion and that ways can be and generally are found to circumvent good policies, unless these are backed by the vigilant insistence of a public that wants them. It suggests that measures to promote desirable land uses in the United States will become effective at about the same rate as public opinion recognizes their usefulness.

Settlement on a mining frontier carries very different social implications than on an agricultural-forest frontier. Settlement and local governmental structures dependent on mineral exploitation must some day or other be liquidated along with the mineral resources, unless substitute means of support be found. Nevertheless, as Professor Innis points out in the course of his interesting treatment of the technological and financial aspects of the industry in different situations, the presence of mining in the Canadian frontier has far-reaching repercussions on the characteristics of agricultural settlement; on the revenues of government; on the problems of public administration; in fact, on the entire economic structure of the Dominion.

C. P. BARNES

STORM RAINFALLS

Storm Rainfall of Eastern United States (Revised), by the Engineering Staff of the District. vii and 352 pp.; maps, diagrs., bibliogr. *Technical Repts.*, Part 5. The Miami Conservancy District, Dayton, Ohio, 1936. 9 x 6 inches.

It is very pleasing to see this book, which was first published in 1918, revised and brought up to date. At the time the first edition appeared there was no other work for any country that was comparable with it, and in the intervening eighteen years no similar work has been done elsewhere.

The 12 chapters of the book agree in title with those of the first edition. In the first edition Chapters 6 and 7 dealt with 160 great storms; in the present edition they deal with 280. In the first edition Chapters 8 and 9 dealt with 33 important storms; in the present edition they deal with 72. The isopluvial charts in Chapter 5 show decided changes in the second edition. These charts are valuable to all those interested in the probability of a locality's experiencing heavy rainfalls. In this chapter (p. 86) the authors state their belief "that a greater refinement of the isopluvial lines should not be attempted until rainfall records become sufficiently abundant to enable the determination of pluvial incides for 1-degree quadrangles or even smaller units of the earth's surface." Naturally such charts would display geographical variation far better than the present ones and we look forward to another revision of the book when the accumulation of data justifies it.

In general, the reviewer feels that the authors could not have found better methods of working up and presenting their material when its nature is taken into account. They might have taken lower limits; for example, instead of considering rainfall depths equal to 10 per cent or more of the mean annual rainfall for a one-day period, or 15 per cent or more for a two-day period, these percentages could have been

made, say, 8 and 12 respectively, though such a lowering of the limits would, of course, have increased the work necessary to obtain the desired results.

The meteorological bibliography (pp. 40–42), a reproduction of that in the earlier edition, with the addition of only four books, is inadequate and out-of-date. Two of the books listed have each gone through two additional revisions, namely the "Smithsonian Meteorological Tables" and Hann's "Lehrbuch der Meteorologie." Moreover, the book "Smithsonian Meteorological Tables" is not out of print. This poor compilation of works on meteorology mars the otherwise high quality of the work. It may also be noted that the curves shown in Figures 44 to 47 are pluvial index curves and not frequency curves.

RICHMOND T. ZOCH

A STUDY OF MIGRATION

MAURICE R. DAVIE. **World Immigration: With Special Reference to the United States.** x and 588 pp.; maps, diagrs., ill., bibliogrs., index. The Macmillan Company, New York, 1936. $3.75. 8½ x 6 inches.

There are, of course, no simple peoples or pure races. All are complex and intricate. Where history fails and there is only mist, we may safely infer the intermingling. But this book deals with historic and recorded movements of men, all the best-known ones. It deals especially with immigration to the United States of America.

Here are samplings from the pages. The nine commonest family names of 1790 in the United States are still within one of being the nine commonest today. Invasions are of low-culture masses; conquests, the reverse in that the higher culture takes the offensive. Immigration into your own people's lands is colonization, unless your colony has assumed the right to say no, as Canada has. Up to and including 1908 about a third of the immigrants to the United States went back, 47 per cent of those to the Argentine went back, three-quarters of those to New Zealand, and 80 per cent of those to Australia. The Scotch-Irish immigrants (colonists?) settled in 500 scattered groups and by the time of the Revolution constituted "the amalgam of the type that ultimately became American"—all Presbyterians!

Up to the time of steam the voyage was a real hazard as well as a matter of hardship. The "indentured servants" promised four years of service to repay the passage. Two-thirds of Pennsylvania's immigration in the eighteenth century was of this type. Of criminals 50,000 were deported to the United States before the Revolution. In the eighteenth century there were more of the white "indentured servants" in the colonies that were to make up the United States than there were of black slaves. They made the clearing of the land possible, and yet they rose in the social scale. Two of the signers of the Declaration had been indentured.

Ireland, we learn, had a great boom in population up to 1840, when it had more than 8 million people, the number in 1800 being 4½ million and in 1700 less than 2 million. As cause it is here alleged that great landowners created large numbers of freeholds in order to obtain votes. (The figures given work out at 40 people to the square mile in 1700 and 260 in 1840, which was in excess of agricultural sustenance power.) It seems to have been this crowded Ireland, under the system of subdivided holdings, that gave Malthus the notion of starvation as a limitation on population.

Might it not be suggested as a special ground for emigration from Scandinavia that these people were earlier aware of world conditions than the people of central and southern Europe? The paths of the sea have always been familiar to them. In 1850, 1511 Norsemen in every hundred thousand were emigrating, 974 in every hundred thousand Swedes, and 577 in every hundred thousand Danes. The Irish were then leaving home at the rate of 2500 to the hundred thousand. France, being of stagnant native population, has had the unique experience in Europe of receiving

a million immigrants since the World War and gets daytime immigrants across its border besides. The real Russian peasant has done his migrating into Siberia. It has been non-Russian peoples within the empire who have emigrated.

The great immigration before the war caused the enlargement of Ellis Island; but under the quota most immigrants now never go near it. We have nine immigration centers abroad where much of the examining work is done. The quota law in its present form may be roughly outlined as follows: 84,000 from the British Isles and 26,000 from Germany; after that about 6,000 each from Italy and Poland, 1000 or 2000 each for a dozen countries encircling these, from Russia through old Austria-Hungary and Switzerland to France, Belgium, Holland, and Scandinavia. The need for universal registration of aliens in the country is urged emphatically. It will be news to many that Michigan has passed such a law for herself, though the Supreme Court disallowed it. Our greatest failure in administering restrictive regulation is said to be unwillingness to grant discretionary powers to our officials. Such discretionary powers enable our Canadian friends to administer a much less complicated law with more success.

One of the most surprising statements of the volume relates to the number of countries with which we do not have naturalization treaties, largely on account of the demand for military service; for instance, we have no such treaty with France, Switzerland, Holland, or any country on the Mediterranean.

MARK JEFFERSON

POLITICAL DEVELOPMENTS IN THE CARIBBEAN

CHESTER LLOYD JONES. **The Caribbean Since 1900.** xi and 511 pp.; bibliogr., index. (Prentice-Hall Pol. Sci. Ser.) Prentice-Hall, Inc., New York, 1936. $5.00. 9 x 6 inches.

"The Caribbean Since 1900" represents a sincere attempt to portray "an objective estimate of the major developments" of the various areas of the Caribbean during the twentieth century. The opening and concluding chapters deal with the region as a whole. Two chapters each are devoted to Cuba, the Dominican Republic, Haiti, Venezuela, Colombia, and Nicaragua, one each to the other republics, and one each to United States possessions and European colonies. Mexico is not included. To understand the developments of the present century a certain amount of background is necessary, and about one-fifth of the entire volume treats primarily historical and political developments preceding 1900. Space devoted to discussion of earlier periods varies greatly with different regions, perhaps warrantably so. The Caribbean areas at different times have played varying roles in international affairs and have witnessed marked changes in the attitude and treatment of them by foreign powers. Since the closing years of the nineteenth century the United States has come to be "by far the greatest of Caribbean Powers." Many conditions have served to accentuate the role played by our country in the affairs of the Caribbean nations and colonies. The important ones have been increased industrialization of the United States, greater dependence upon them for markets of manufactured wares and for raw materials and foodstuffs, political expansion of the United States into Puerto Rico, the Canal Zone, and the Virgin Islands, political involvement of the United States in the affairs of several of the republics, and heavy investment of American capital in many of the units. Also the part the United States played in the settlement of points of friction between certain Caribbean nations and European powers and the withdrawal of most of the fleets and armed forces of the European nations from their Caribbean colonies have augmented the role of the United States in the affairs of these areas.

These and other topics the author analyzes in his treatment of the relations of the United States to the Caribbean areas and of these areas to one another. The volume

is largely a portrayal of the evolution and clarification of American foreign policy towards the Caribbean nations. Social conditions and economic development in the different units are treated only in connection with internal political conditions and international political relationships. The volume contains no analysis of the sugar business of Cuba, the banana industry of Costa Rica, or any other major industry of the region. But these developments have played significant roles in the political affairs of the nations, and the author's method of handling them has strengthened the volume by maintaining unity of treatment throughout. The volume points the way for a better understanding of the relation of the American nations to one another and to closer economic and political coöperation between two great areas that, because of modern industrial and agricultural expansion, must have increasing economical contacts.

CLARENCE F. JONES

SOUTHERN NIGERIA

PAUL DITTEL. **Die Besiedlung Südnigeriens von den Anfängen bis zur britischen Kolonisation.** Maps, diagrs., bibliogr. *Wiss. Veröffentl. des Deutschen Museums für Länderkunde zu Leipzig, N. S. 4*, 1936, pp. 71–146. 12 x 8½ inches.

In line with European interest in Africa as a source of raw materials and as a market for manufactured goods is this comprehensive study by Dr. Dittel. Preliminary to a discussion of the resident peoples of the region, their history, institutions, agriculture, commerce, and industries, the author outlines the physiography of the southern half of present-day Nigeria. The topography ranges from alluvial lands at sea level to crystalline mountains of 1500 meters' elevation. The Niger, with its complicated deltaic mouth, and the Cross are the main streams, varying in discharge with precipitation. Rainfall is seasonal, occurring principally from March to December during the southwestern monsoon winds. Precipitation varies from as much as 4388 millimeters annually at Akasa on the coast to 1260 millimeters at Lokoja 300 kilometers inland. A sharp decline in rainfall occurs in August, of importance in cultural operations. During January and February the dry northeastern Harmattan winds blow from the Sahara. Temperatures at sea level are equable, with a yearly range of only 5.9° C. at Lagos, rising to 12.7° at Ibadan 110 kilometers inland.

Vegetational zones are well marked. The mangrove swamps in brackish water along the seaboard are succeeded by the dense tropical rainforest with many valuable trees—mahogany, copal gum, African oak, ebony, and rubber—then comes the more open monsoon forest largely cleared for agricultural uses, and finally the grassy savanas diversified with a scattered growth of gnarled and crooked trees. After many centuries of human occupation, much of the original plant cover has been replaced by second growths and by economic plantings of the oil palm, the cacao tree, the kola nut, bananas, and plantains.

The population of Southern Nigeria now averages 42 inhabitants to the square kilometer, next to Egypt the most densely occupied part of Africa. Paleolithic artifacts indicate prehistoric peoples, followed by successive waves of invasion from the north due to increasing desiccation of the Sahara. Cultural influences have reached the region both by way of the Atlantic and overland. The Phoenicians undoubtedly traded as far south as the Cameroons as early as 500 B. C., and Egyptian influence penetrated from the northeast as early as 2000 B. C. Knowledge of bronze came from the Mediterranean, but it seems possible that the art of iron smelting originated in interior Africa, using the widely occurring ores of lateritic origin.

Political organizations have ranged from patriarchal units to the great monarchical states of Benin, the Yoruba, the Mohammedan Emirates. Wars between native tribes have contributed prisoners to the slave trade, begun by the Portuguese who penetrated the region commercially in the fifteenth century. [Abolished for more

than a century, the slave trade is still remembered in native folklore and legend. The natives of remote Sassandra, on the Ivory Coast, are said still to make a ritual flight into the forest when the smoke of a steamer (succeeding to the sails of the slave ships) is seen at sea.]

Agriculture is the main occupation in Southern Nigeria, varying greatly in detail according to locality. Important crops are yams, sorghum grains, manioc, maize, colocasia, calabashes, peanuts, and cotton. Yams, in particular, are grown by laborious hill culture in varieties that mature during several months of the year. Palm oil and palm kernels constitute the principal exports from Southern Nigeria and the oil is also an important item of internal trade. Bananas and plantains also are important food stuffs.

Agricultural labor is specialized between men and women. For cotton, men clear the land and break ground; women harvest the crop and spin the fiber; men weave the cloth. [It may be noted that these organizations of labor were broken up by the slave trade, whence the failure to continue with much of the native craftsmanship in the New World.]

Iron working, pottery manufacture, salt making, and basket weaving are industries sometimes specialized in by whole villages, as is also the fishing industry employing baited traps, nets, hooks, and stupefying fish poisons.

Sheep, goats, swine, and poultry are kept, also dogs both for hunting and to eat. Horses and cattle are restricted to localities free from the tsetse fly. Transport is by caravans, by porters, and by canoes along the waterways. The wheel for transport was unknown before European penetration. Markets, sometimes held formerly on neutral ground between hostile tribes, are conducted largely by women in weekly rotations from village to village.

Architecture and arrangement of towns are influenced by materials available, by location (swamps, savanas), by defensive needs, for marketing facilities, and for ceremonial uses. Surrounding the towns are cultivated zones sometimes fertilized by village wastes. At a distance cleared areas are farmed until the soil is exhausted, then left fallow.

Much of the substance of Dittel's excellent presentation applies to West Africa in general. This is true of agricultural practice, of the iron, pottery, and cotton crafts, of methods of transport, of marketing practices, of architectural construction, and many native customs. The prospective West African traveler to whom this work is accessible will go well prepared to understand much of what he is to encounter.

Exhaustive references, 282 in number, testify to the thoroughness of the research on which the discussion is based.

ROBERT H. FORBES

HANDBOOK OF THE GEOGRAPHY OF THE NETHERLANDS

R. SCHUILING. **Nederland: Handboek der aardrijkskunde.** Vol. 1, xix and 821 pp.; Vol. 2, xxiv and 1074 pp.; maps, diagrs., ills., bibliogrs., index. 6th revised and enlarged edit. J. J. Tijl, Zwolle, 1934 and 1936. Vol. 1, Fl. 12.75; Vol. 2, Fl. 17.25. 10 x 7 inches.

The two volumes under review constitute the sixth edition of a "Manual of Geography" first published in 1884. The original book was a work of some size, but it shrinks into a mere outline when compared with the present two enormous volumes. The four decades that intervene have witnessed an extraordinary development in the science of geography, and of this progress and expansion the history of the books before us is an epitome. This sixth edition is truly encyclopedic in scope—a vast treasure house of facts—and the final and crowning achievement of the life work of the author. Mr. Schuiling took upon himself this task of revision when he was past eighty and died soon after the completion of the second volume in 1936.

The work is divided into sections and arranged in textbook style. Section A deals with the country as a whole and includes chapters on geology, climatology, hydrography, fauna and flora, and finally a chapter on prehistory and anthropology. Section B takes up description in detail of the eastern and southeastern provinces; Section C covers the northern and western provinces. Both are rich in supplementary information—historical, philological, sociological, economic, archeological—which serves to throw light upon the more strictly geographical facts set forth. In Section D agriculture, land tenure, and communications are discussed. Section E contains a study of the Dutch people, their language, religion, education, national characteristics, and so forth, in the course of which the author introduces a mass of information regarding folklore, dialects, history of proper names, local expressions, and the like. Section F is a discussion of military defenses, with special reference to geological and hydrographical conditions. A final section outlines the general condition of affairs in the Netherlands' colonial possessions and includes a short chapter on the strategic position of the Dutch East Indies and the military and naval forces available in case of need.

Both volumes are generously illustrated with photographs, charts, and maps of every description—geological, geographical, and statistical—many of them original and here published for the first time; each chapter is followed by a comprehensive bibliography of books in various languages; and the work of the student is facilitated by numerous cross references in the text and an index at the conclusion of Volume 2. The whole subject has been brought up to date even in the minutest detail.

A. DE LEEUW

POLITICAL GEOGRAPHY OF THE AUSTRALASIAN MEDITERRANEAN

KURT WIERSBITZKY. **Politische Geographie des australasiatischen Mittelmeeres.** 126 pp.; maps, bibliogr. *Petermanns Mitt. Ergänzungsheft No. 227*, 1936.

This monograph makes available for the first time a clear and comprehensive geopolitical survey of an extremely important part of the Pacific, the Australasian Mediterranean. To this area belong the South China Sea, the Malacca Strait, and the several seas of the Malay Archipelago together with Siam, French Indo-China, British Malaya, Netherlands East Indies, Philippine Islands, British Borneo, and Portuguese Timor. The Chinese have a name for the whole area, "Nanyang"; the Japanese call it "Nanyo."

The importance of the Australasian Mediterranean lies in the fact that it is a double gateway between two continents and two oceans. In a relatively small region three great colonial powers meet each other, a fourth is withdrawing, and a fifth wishes admission to strengthen its economic position and to find new outlets for its population. In the center is Siam, the only part of southeastern Asia that has been able to preserve its independence.

We find in this area sharp contrasts in the distribution of population—from high densities in Java to large sparsely populated areas waiting for capital and climatically adapted agriculturists and laborers. Limited parts have been opened in recent decades by capitalistic entrepreneurs with the help of Chinese, Indian, and Javanese labor. Will Japan join the group of the pioneers? The results in Formosa and in Davao Province, Mindanao, prove that it is not impossible for her people.

The monograph deals systematically with position, size, and boundaries; the physical and anthropogeographic foundations; the economic and politico-geographic structure, first for the individual parts of the region—Farther India with the Malay Peninsula, the Malacca Strait and the South China Sea, the Malay Archipelago—then in a comparative analysis of the whole region. This brings out the unity and the diversity of the Australasian Mediterranean. The far-reaching

influence of the ocean, the considerable differences in the distribution of population within limited areas, rice as the main food, and the strong position of the Chinese are characteristic of the entire region. On the other hand, the extent and the fragmentation of the region cause important regional differences, which are specially noticeable in native folkways. The multiplicity of native units and groups made easy European entry and mastery, and in the future it will be the greatest hindrance to unification of national movements among the natives. The situation as a whole is one of great complexity; many and diverse interests are entangled, and crises might easily arise that would completely change the political picture of the Australasian Mediterranean.

A comprehensive bibliography, clearly arranged, gives us valuable assistance for further studies. Also worthy of mention are the three excellent insert maps showing respectively position and boundaries; physical structure, natural and cultural landscape; formation of states and the regional growth of European colonial possessions. They illustrate and supplement the text.

KARL J. PELZER

THE SI KIANG REGION OF SOUTH CHINA

GUSTAV FOCHLER-HAUKE. **Die Natur des Si kiang-Stromgebietes (Südchina).** Maps, diagrs., bibliogr. *Mitt. Geogr. Gesell. in München*, Vol. 27, 1934, pp. 143–266.

GUSTAV FOCHLER-HAUKE. **Das Waldkleid und die Pflanzenbezirke Süd-Chinas.** Map, bibliogr. *Mitt. Geogr. Gesell. in Wien*, Vol. 78, 1935, pp. 158–178.

It is a striking characteristic of Chinese geography that more attention has been given to remote regions such as Tibet than to many more accessible areas. Of these areas, that of the Si Kiang or West River is one of the most neglected. The watersheds of the Si Kiang, the Pei Kiang or North River, and the Tung Kiang or East River together form a cultural as well as a physical unit. These three rivers focus on Canton, which itself lies on the small Chu Kiang or Pearl River. The first of these two articles by Fochler-Hauke is intended to fill in some of the gaps in our knowledge of the geographical structure of South China as a basis for the study of its cultural conditions.

"The Si Kiang or West River follows the Yangtze and the Hwang Ho as the third greatest stream in China with respect to length and drainage area . . . Next to the Yangtze it is by far the most important commercial river of the country, and for retail trade it is undoubtedly one of the foremost rivers of the earth." During the monsoon season the three rivers pour into the Canton delta a maximum of 56,000 cubic meters a second, which is reported to be 5 or 6 times greater than the flow of the Hwang Ho.

The Si Kiang has a probable length of 2000 to 2100 kilometers and drains 400,000 square kilometers. At high water ships drawing 4 meters may reach Wuchow, 330 kilometers from the mouth, and small steamers go to Nanning, 670 kilometers farther. Native junks may be used to the boundaries of Kweichow and Yunnan. The Pei Kiang is 480 to 500 kilometers long and drains 55,000 to 60,000 square kilometers. The Tung Kiang is 440 to 460 kilometers long; its drainage area is unknown. The lack of satisfactory maps makes precise figures impossible. The river pattern is noticeably independent of the geologic structure.

The discussion of the rivers is followed by a consideration of stratigraphy and structure, climatic provinces, and landforms. Fochler-Hauke divides the area into three climatic regions: (1) the warm tropical monsoon climate of the coastal region of South China, which lies within the tropics except for certain protected areas where it extends as far north as latitude 24° N.; (2) the transitional temperate-subtropical monsoon climate of the Middle China plant district, in northern Kwangtung and

Kwangsi; and (3) the cool, dry winter monsoon climate of the highlands of Yunnan.

The monograph is based on field studies and represents scholarly work. The absence of a base map is regrettable.

In the second article Fochler-Hauke discusses the natural vegetation of these same three areas. Because of the combination of tropical and high-mountain climates and the absence of pronounced glacial climatic repression, the flora of South China is particularly rich. "The Chinese plant world is undoubtedly one of the richest floras of the earth, for it numbers at least 15,000 species, of which more than half are found only in China; almost all coniferous species and more than 260 deciduous trees are here represented."

GEORGE B. CRESSEY

SEISMOLOGY FOR THE GENERAL READER

NICHOLAS HUNTER HECK. **Earthquakes.** xi and 222 pp.; maps, diagrs., ills., bibliogr., index. Princeton University Press, Princeton, 1936. $3.50. 9 x 6 inches.

The author undertakes to present to the lay reader a general discussion of earthquake phenomena and to outline for him the programs of study that are now under way, particularly with regard to the United States. As Chief of the Division of Terrestrial Magnetism and Seismology of the United States Coast and Geodetic Survey, he is in close touch with the work carried out not only by his own bureau but by the other organizations in the United States with which they coöperate closely in direct seismological research: the Carnegie Institution of Washington, the Jesuit Seismological Association, and various educational bodies such as the Massachusetts Institute of Technology and the California Institute of Technology, the University of California, etc. He has for some years been connected with the activities along seismological lines of the International Union of Geodesy and Geophysics. At the Edinburgh meeting, 1936, he was elected chairman of the Association of Seismology of that Union. He has also been actively engaged in the seismological program of the Pacific Science Association. From such wide resources of experience and affiliation he is able to draw freely. The result is a book of concentrated, authoritative, and intensely interesting data.

The format is excellent, the type clear, the paper and the binding good; the 88 illustrations are all clear and well defined. An excellent index is provided. The bibliographical items, "References on General Seismology," are not quite so satisfactory. The list might be improved by omitting some books that are obsolete and adding other modern texts of marked interest and value.

The chapters, in order, deal with the subjects: Earth Vibrations, Effects of Earth Tremors, The Cause of Earthquakes, Release of Forces, Earthquake Study without Instruments, Earthquake Study with Instruments, Present Seismographic Stations of the United States, Earthquake Records and Their Interpretation, Location of Earthquake Epicenters and Foci, Seismic Belts of the Earth, Description of Great Earthquakes, Earthquakes of the United States, Regional Investigations, Regional Investigation in Japan, Safe Construction in Earthquake Regions, Summary of Earthquake Information, History of Seismology.

The author has carefully considered his reader and so introduces the subject, step by step, that all knowledge essential to the understanding of any particular description has been given in an earlier part of the development. Any slight inaccuracies in the text must be laid to the necessity for omitting details in preparing a book on earthquakes for the general reader. No inaccuracy of any importance has been detected by the reviewer. The only serious criticism that he has to offer is that the book is somewhat lacking in perspective. While the author states that "special emphasis is necessarily laid on seismology in the United States" and hence the lack of perspective with regard to other countries must be overlooked, the fact remains

that the important basic seismological work in the United States previous to 1925 is almost ignored. The book thus fails properly to assess the work done by such men as Branner, Lawson, Louderback, Marvin, Tondorf, Townley, Woodworth, and others.

The seismological work in Japan is dealt with in some detail; the criticism of the previous paragraph does not here apply. A thought-provoking statement is made by the author on page 189: "Only a portion of the activity of the Earthquake Research Institute has been described, but it has been clearly brought out that a well selected group of scientists and engineers with earthquake study as their single aim can find many problems and new methods of attack on them, and can make important contributions to knowledge." The description of the seismological work in the United States by the various associated organizations provides the reader with another well developed instance of this important generalization. Perhaps no one but the author of this book is quite qualified by his experience and his general interests to paint so clear a picture of the United States' seismological coöperation as that which appears in the later chapters of "Earthquakes."

"Earthquakes" can be warmly recommended to all who wish to obtain a clear conception of the nature of the phenomena with which it deals and the importance of the many lines of study associated with them.

ERNEST A. HODGSON

RAILWAY AND AIRPLANE TRANSPORTATION COMPARED

CARL HANNS POLLOG. **Eisenbahn und Luftfahrzeug in ihrem Kampf gegen die älteren Verkehrsmittel.** Maps. *Geogr. Zeitschr.*, Vol. 41, 1935, pp. 462–480.

The development of the steam engine and the development of the airplane are considered to be the most significant advances in modern transportation, the development of the steam engine because it marks the introduction of the machine into transportation problems, of the airplane because it brings into use a third dimension in space relations. The evolution of these means of transportation is worthy of comparison.

In the first days of aerial navigation, up to the beginning of the World War, flying was considered equivalent to suicide; in the first days of the locomotive human lives were endangered by the likelihood of boiler explosions. Technical problems in the mechanical improvement of the locomotive challenged the genius of man. Problems of overcoming grades, tunnel construction, bridge building, track width, and night operation had to be solved in due course. Likewise, improvements in airplane construction have had to be made, and such problems have arisen for solution as blind flying, night flying, and the overcoming of various atmospheric obstacles.

The introduction of railroads effected an immediate reduction in the cost of transportation as well as in saving of time. In contrast, aviation charges were higher than those of other forms of transportation, and, besides, the kinds of freight transported have been limited. However, like the railroad, the airplane, too, reduced time. Relatively speaking, aerial transportation in Europe today, expressed in terms of time, bears the same relation to the railroad that the railroad a hundred years ago bore to highway transportation.

The airplane has blazed few trails. Nowhere has a regular route been established before commercial settlement. However, in many areas the airplane has brought about quick and convenient connection between relatively isolated localities and major centers—and has accomplished the feat far more economically than the railroad could have done.

It is noteworthy that, whenever a new mode of transportation has been devised, so far as possible it has followed routes already established by its predecessor. This, of course, is natural, since the more important cities must be connected and estab-

lished trade routes may not be ignored. The relationship is borne out in an interesting manner by a comparison of List's map (1833) showing a proposed railway network for Germany with present-day maps of the main aviation routes. They are almost identical.

In the early days of railroading, the depot was often located on the city outskirts, just as today the airport is distant from the heart of the trade centers. However, at present the railroad station has become an integral part of the urban physiognomy. Settlement has spread toward the station and beyond. Aviation companies provide transportation between the airport and the business district by including that item in the ticket charge. On the other hand, railroads no longer concern themselves, in Germany, with this connection, though in their earlier days private companies were organized especially to take care of such traffic. (Parenthetically it may be noted that in the United States railroads are beginning to offer a "door to door" express and freight service.)

The airplane has been able to free itself from many of the physiographic elements that still play a large part in the cost of operation of, and the fixation of routes by, railroads. Mountains, water bodies, and atmospheric conditions are almost vanishing as serious obstacles to aviation.

The length of aviation routes has increased far more rapidly than that of railroad routes. For example, in Germany the first railroad had a length of six kilometers, whereas in the first year of aviation the network length was 933 kilometers. Ten years later the railroad network covered 2838 kilometers and the aviation routes 35,974 kilometers.

Some overenthusiastic supporters of aviation believe that railroads and steamships may be entirely suppressed. Although this is not likely to happen, certainly vast areas of the earth still awaiting transportation connections with other areas will some day realize their hopes through the aid of the motor vehicle and airplane, but they will never see the railroad.

EUGENE VAN CLEEF

GEOGRAPHICAL INTERPRETATION OF THE COURSE OF HISTORY

GRIFFITH TAYLOR. **Environment and Nation: Geographical Factors in the Cultural and Political History of Europe.** 571 pp.; maps, diagrs., index. The University of Chicago Press, 1936. $4.00. 9½ x 6½ inches.

Professor Griffith Taylor is one of our most versatile geographers. At first chiefly interested in problems of physiography and climate, he showed, in his publication "Environment and Race" (1927), preceded by two articles in *The Geographical Review*, a distinct shift from the physical side of geography to a study of anthropology and from the limited fields of the Antarctic and Australia to that of the entire world. "Environment and Nation" completes the shift. Although limiting his study to Europe, Taylor tackles the immense problem of giving a geographical interpretation of the sequence of historical events in the life of nations. His book is packed with material presented generally in a most original way. One may not always agree with his interpretation of facts, one may sometimes deplore the use of hypotheses as bases for further study; but the reading is always fascinating. His training in geology and meteorology proves a great asset and helps to give a clear picture of the natural environment of the nations of Europe. Another asset, which puts his book ahead of most former efforts, are his many map illustrations.

The book contains five parts; the first two are general in approach, the last three regional. Part I lays the physical base for the history of Europe, the structural and climatic controls of the continent. Part II develops the author's ideas on the distribution of races and languages. It seems to the reviewer that the author overestimates the importance of language as a factor of nationality and irredenta—there

are too many exceptions to the rule. The second section of Part II gives a short survey of the older history of Europe from the cave man through the periods of Greece and Rome and the Nordic migration to the end of the Renaissance, which brings the story down to 1648.

The studies of individual countries (Parts III, IV, and V) are arranged according to religion: the Protestant nations of northwestern Europe, the Catholic nations of southwestern and central Europe, and the eastern nations, belonging mainly to the Greek Church. This leitmotiv, religion, leads to certain complications. One is rather surprised to find Belgium—a one-hundred-per-cent Catholic country—as part of the Netherlands under the heading "Protestant Nations," whereas Germany has a too important Catholic minority to be ranked according to religion. But this does not interfere with the chapters themselves, which show a remarkable knowledge of the countries concerned—both from books and from personal contact.

After reading the book and enjoying it greatly, I was left with two objections. The first and principal one is the lack of blending in many cases between history and geography. The historical section in many instances reads like the Encyclopaedia Britannica, as the author acknowledges; but the relation between the historical data and the excellent geographical observations preceding them is often missing. Also I looked in vain for a reason why the Dutch Republic in the seventeenth century was the most powerful nation of Europe. In the chapter on Switzerland the greatest historical event since the founding of the state—the battle of Marignano—is not mentioned, although it marked the end of a dream of European greatness; and with it of course is missing the geographical background that almost caused the dream to come true. During the reading a number of questions rose in my mind that were left unanswered. If the proper blending could be accomplished, the book would gain much in value.

The second objection is the maps, which have been mentioned as an asset but have to be mentioned again as a liability. I hope the author will forgive me when I say that I was often happy when an old-fashioned map came along. I appreciate Taylor's originality with his time-space diagrams, his sheetfolded languages, and his parkways between ethnographic buildings, many of which are real contributions in the interpretation of complex relationships; but often ordinary maps would have illustrated the point just as well. To readers not well acquainted with the geography of Europe some of the author's maps must be unintelligible: for example, the structural map on page 57 and the physical map of Germany on page 259. It is also to be regretted that some maps are reproduced on such a scale that they do not give a clear picture, such as those on the relations between national indices and religion and health respectively.

These two objections, however, do not lessen my esteem for the book. It is written with such a great and intimate understanding of Europe and its problems that I want to express the hope that Professor Taylor may be tempted to continue his study and give us his interpretation of the present situation on the European continent.

SAMUEL VAN VALKENBURG

HISTORY OF CARTOGRAPHY

Imago Mundi: Jahrbuch der alten Kartographie, No. 1. Edited by Leo Bagrow and Hans Wertheim. Bibliographicon, Berlin, 1935. RM. 4.80.

Imago Mundi is the result of an ambitious attempt to create a periodical devoted exclusively to the history of cartography. The first number, which has been rather slow in making its way to American scholars, contains articles in both German and English on a wide variety of subjects, besides brief notes and items of current interest to specialists. The principal contribution comes from Richard Uhden of Braun-

schweig, "Die antiken Grundlagen der mittelalterlichen Seekarten," Dr. Uhden reopens the old question of the origin of the medieval portolan charts and by piecing together fragments of evidence attempts to show that the navigation charts of antiquity may well have served as a basis from which those of the Middle Ages evolved without break of continuity. The argument is close but rather tenuous. The relics of ancient cartography that have survived do not impress us as works of minute accuracy. It seems almost unthinkable that outlines in any way comparable with those on the portolan charts could have been achieved by navigators who had no compass; and there are other objections to this theory. In fact, despite all that has been written on the subject, the origin of the portolan charts still remains mysterious.

The other articles deal for the most part with special subjects. Albert Herrmann of Berlin describes a world map compiled in the year 1076 by a Turk from Kashgar, which ranks not only as the "oldest, but also the only important cartographic monument of the Central Asiatic Turks." George Kimble of Hull reëxamines the famous Laurentian world map and concludes that "there would appear to be good reason for retaining 1351 as the approximate date of the original drawing, and for regarding the African outlines as the work of later editors: the first dating possibly from the period of the da Virga world map, and the second from the period of Portuguese activity along the west African coasts." Karol Buczek of Cracow publishes a short letter of Sebastian Münster, illustrating the way in which this Renaissance geographer collected material for the description of particular countries—in this case Poland—in his "Cosmography." Hans Wertheim, coeditor of *Imago Mundi*, calls attention to the "Itinerarium Orbis Christiani," one of the many atlases published in the wake of Ortelius' great compilation. The author of the "Itinerarium," presumably Metellus, sought to provide a compact, usable collection of road maps for travelers and thus inaugurated a new type of atlas, one designed rather for the practical man than for the scholar and the amateur. Franz Taeschner describes the seventeenth-century "Kosmorama" of the great Turkish writer Kātib Čelebi, which was of epoch-making importance for the geography of the Ottoman world, since it marked a decisive transition from Oriental to Occidental conceptions. Notes on a seventeenth-century Dutch "Pilot" and the Swedish matricular maps of Pomerania complete the original articles. Historians of geography will read with interest, however, the brief account that Father Josef Fischer of Feldkirch has given of his long life devoted to scholarship. And for American readers Professor Karpinski's list of the cartographical collections in the United States will be a useful reminder of our own extensive resources. There are also accounts of the International Geographical Congress at Warsaw and of societies, meetings, and exhibits in various countries, several excellent reviews, and a bibliography of the field for the year 1933.

This distinguished, cosmopolitan publication will surely win the support and approval of American specialists in the field. It is anticipated (February) that the second number of *Imago Mundi* will appear shortly.

DANA B. DURAND

STEJNEGER'S LIFE OF STELLER

LEONHARD STEJNEGER. **Georg Wilhelm Steller: The Pioneer of Alaskan Natural History.** xxiv and 623 pp.; maps, ills., bibliogr., index. Harvard University Press, Cambridge, 1936. $6.00. 8¼ x 6 inches.

Steller was the young German naturalist who accompanied Bering on the voyage of 1741 from Kamchatka, on which Alaska was discovered. His journal of this voyage, the outstanding of the only three extant connected accounts by participants, was published by the Society in 1925 in a translation by the author of the present biography in Volume 2 of "Bering's Voyages," by F. A. Golder (*Amer. Geogr. Soc. Research Series Nos. 1 and 2*). All except the first three years of Steller's scientific

career were spent as a member of Bering's second expedition (from 1737 to his untimely death in 1746), and an account of his life is therefore almost equivalent to an account of that great undertaking. As the present work is based on a consummate mastery of the source material in all its wide ramifications, it will immediately take its place in the front rank of the few existing authoritative discussions, namely those by G. F. Müller (1758), Sokolov (1851), Lauridsen (1885), and L. S. Berg (1924 and 1935).

Dr. Stejneger's special qualifications for the present undertaking in the field of natural history and as regards long personal familiarity with the North Pacific and with the regions visited by Steller in Alaska, the Aleutian Islands, the Commander Islands, and Kamchatka are well known. The rich harvest of achievement they have yielded forms part of the enviable record of the United States National Museum and of American science in general. But, in addition, the present work reflects throughout the qualities of the historical scholar, especially that exercise of critique in the appraisal and use of documentary evidence that is so essential for the proper reconstruction of truth. And the critical sense is indeed necessary in handling the diverse material that goes to make up the story—official documents, letters, naval reports, zoölogical and botanical memoirs, biographies, and works of travel and history, both manuscript and printed, in Russian, German, Swedish, Danish and Norwegian, Dutch, French, English, and Latin, among the archives, libraries, and collections of Europe, Siberia, and the United States. Only someone with the present biographer's wide contact and familiarity, through training and national origin, with the various civilizations involved and their modes of life and thought could have produced this work.

It is these attributes of the present biography that make it an indispensable supplement to Golder's "Bering's Voyages." The late Professor Golder's great contribution was publishing the log book of Bering's vessel and the journal of Chirikov's for the first time in any language and making accessible photostats of these and related original documents from the Russian archives. He accompanied these documents with a brief account of the expedition and a bibliographical note; but, as the expedition details lay outside his primary research field, it was not possible, even with editorial reënforcement, to do full justice to the theme or insure rigorous accuracy and correct interpretation of all its multitudinous particulars.

Some of these that need emendation may hence be briefly noted here: the track of the *St. Peter* on approaching Bering Island passed north and not south of Copper Island (Stejneger, p. 310 and Pl. XVI, as against Golder, Vol. 1, Pl. I; also noted by Stejneger in Golder, Vol. 2, Fig. 15); the channel between Kayak Island and the mainland might have been deep enough in 1741 to allow the *St. Peter* to pass, inasmuch as the present shallow depth may be due to the glacial sediments brought down by the Bering River since that time (Stejneger, p. 283; Golder, Vol. 2, p. 36); the two vessels shown in the view of Avacha Bay (Golder, Vol. 1, Fig. 8) are not Bering's vessels, which "carried two masts brig-rigged" (Stejneger, p. 244); Steller never made a second trip to Bering Island (Stejneger, pp. 439–440; Golder, Vol. 2, p. 3); Steller was not in a drunken stupor immediately before he died, as related by Golder (Vol. 2, p. 4) on the basis of the accounts by Scherer and Büsching, the actual circumstances of his death being quite different (Stejneger, pp. 493–494 and 485–486).

This is not the place to discuss the biography as a whole. Certain parts, such as those dealing with Steller's childhood and young manhood in Germany and the purely taxonomic passages on zoölogy and botany, do not concern geography; but it should not be left unsaid that, although the author expressly disclaims writing a "psychological" biography, the book, as the story of a vigorous and forthright personality in a Homeric setting, provides fascinating reading.

Of geographical matters on which the book sheds new light it will be possible to deal with one only, but this one relates to what in some respects is the geographical

quintessence of the whole expedition—the original charts of the voyage. In Golder's work only fragmentary references could be made. Now, however, through Dr. Stejneger's keen analysis of the question of the original drawings of the fur seal, the sea lion, and the sea cow that appeared on the charts as insets, it is possible to unravel the maze as to the identity, location, and relationship of the charts themselves. The situation seems to be as follows:

A provisional draft chart was prepared at Petropavlovsk and forwarded with his report of November 15, 1742, by Lieutenant Waxell, in command after Bering's death (Stejneger, p. 512; Golder, Vol. 1, pp. 281 and 275). This material reached Yakutsk in May, 1743, whence copies, including copies of the chart, were despatched by Chirikov to St. Petersburg, where they were delivered at the Admiralty, September 4, 1743 (Stejneger, p. 400). The probabilities are that the original draft chart never reached St. Petersburg (*ibid.*, p. 512).

During the winter of 1743–1744 in Yakutsk Waxell and Khitrov of the *St. Peter* prepared the final chart and sent it to St. Petersburg, where it was still in existence in 1754. This original seems to be lost, but a certified copy, about 68 by 26 inches in size (Stejneger, p. 513), was still in the archives of the Hydrographic Office in St. Petersburg in 1914 as item No. 1940, dated 1744, in the manuscript charts (F. A. Golder: Guide to Materials for American History in Russian Archives, Carnegie Institution, Washington, 1917, p. 131). The chart from the Upsala University library, of lesser geographical interest because lacking the ships' tracks, which Dall designated as an original and of which he published a tracing in the *U. S. Coast and Geodetic Survey Report for 1890* (Pl. 70) is, according to Stejneger (pp. 515–519), who owns a photograph of it, merely a copy in English—possibly even the same copy mentioned by Middendorff as being in the St. Petersburg Academy of Sciences in 1867—of another chart which also served as a basis for the chart in German that accompanies Waxell's unpublished manuscript account of the expedition that was in the Czar's private library at Tsarkoe Selo in 1891 (see "Bering's Voyages," Vol. 2, Fig. 29). Of the certified copy of the original chart of the voyage of the *St. Peter*, No. 1940, a reduced facsimile was published in *Morskoi Sbornik*, No. 255, May, 1893 (and incidentally also of the chart showing the tracks of both the *St. Peter* and the *St. Paul*, possibly the item No. 834 in Section 10 of the Military-Historical Archives of the General Staff in Golder's "Guide," p. 117, and in any case the map reproduced by Sokolov and republished by Lauridsen that shows the longitude gaps in the track of the *St. Paul* discussed in "Bering's Voyages," Vol. 1, pp. 308, 313, 322).

Of these highly important published facsimiles of the voyages of the *St. Peter* and the *St. Paul* Professor Golder was apparently not aware when he wrote "Bering's Voyages"; hence the late Captain Bertholf, who had been invited to reconstruct, from the log books and other translated documents, the tracks of the two vessels in terms of the modern chart, was also unaware of them. A comparison of Captain Bertholf's reconstruction (*ibid.*, Vol. 1, Pl. 1) with the facsimiles in *Morskoi Sbornik* shows how remarkably accurately, even without the aid that these would legitimately have afforded, he solved the problem. An interesting superposition on the same scale in Dr. Stejneger's book (Pl. XIV) of the track of the *St. Peter* according to Bertholf and according to the facsimile of No. 1940 brings this out strikingly and furnishes Dr. Stejneger the opportunity of pointing out how excellent had been the navigation of the *St. Peter's* officers before they were stricken down by scurvy. This was also Captain Bertholf's testimony. The confrontation of these two nautical documents, one of long ago and the other of today, reveals once again, as does so fully Dr. Stejneger's book itself, the permanence and the universal validity of work well done, in which the mind, in this case, has leaped over the additional barriers of time and space, literally to span the earth.

W. L. G. JOERG

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